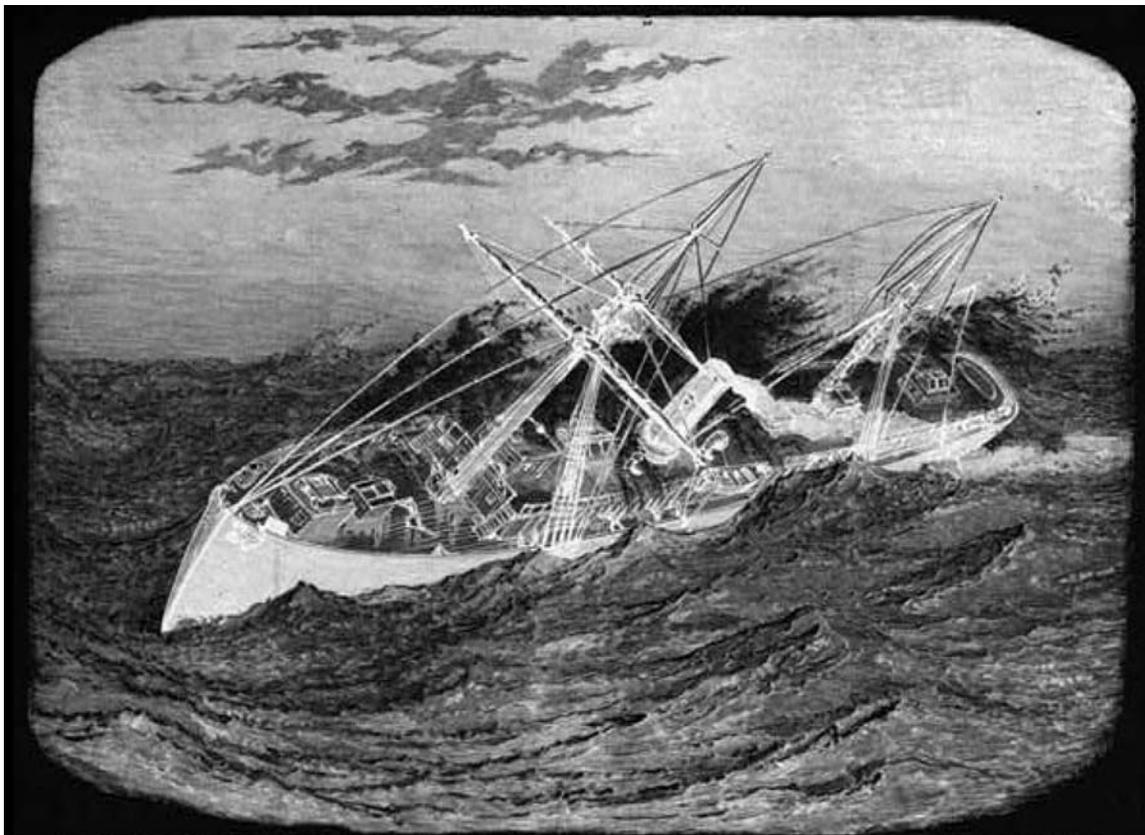




Inventory and Analysis of Archaeological Site Occurrence on the Atlantic Outer Continental Shelf



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ABBREVIATIONS AND ACRONYMS

ACHP	Advisory Council on Historic Preservation		statistical analysis and cartography.
AMS	Accelerator Mass Spectrometry	GMWD	Global Maritime Wrecks Database, published by General Dynamics Advanced Information Systems with more than 250,000 shipwreck locations worldwide currently included.
ArcGIS	geographic information system software		
ASD	Atlantic OCS Shipwreck Database		
ARIF	Archaeological Resource Information Form		
AUVs	Autonomous Underwater Vehicles	HMS	Her Majesty's Ship, designation for British royal navy ship names.
AWOIS	Automated Wreck and Obstructions Information System, a database of wrecks and obstructions compiled from hydrographic surveys and field reports maintained by NOAA.	h.p.	horsepower
B.P.	years before present	ICA	Institute for Conservation Archaeology, consultant that prepared the previous Bay of Fundy to Cape Hatteras study of the OCS for MMS.
BOEM	Bureau of Ocean Energy Management (formerly Minerals Management Service, within the Department of Interior)	IRSS	International Registry of Sunken Ships, a commercial database of shipwrecks.
C ¹⁴	radioactive isotope of carbon measured to calculate radiocarbon dates.	LIS	Laurentide Ice Sheet
CHIRP	Compressed High Intensity Radar Pulse, a shallow multi-frequency seismic sub-bottom profiling system	LGM	Last glacial maximum
CSS	Confederate States Ship, designation for ship names in the Confederate Navy.	LORAN	LONG RANGE Navigation, a terrestrial radio navigation system using low frequency radio transmitters to determine the location and speed of the receiver from multiple stations to generate coordinate locations.
DSF	Data Source Form	MMS	Minerals Management Service, body formerly within the Department of Interior that regulated and permitted mineral leases and energy development on the Outer Continental Shelf, currently named Bureau of Ocean Energy Management (BOEM).
EFC	Emergency Fleet Corporation, body created by the U.S. Shipping Board to build up the merchant marine fleet.		
ELI	Environmental Law Institute		
GIS	Geographic Information System, a tool for integrating spatial data with other information to allow sophisticated spatial and	mtDNA	deoxyribonucleic acid contained within mitochondria, cellular organelles with their own genetic material inherited only from the female line.

MWP	Melt water pulse (period believed to represent a rapid rise in global sea levels)	PIDBA	Paleoindian Database of the Americas, a collection of locational data and measurements of attributes for late Pleistocene and early Holocene projectile points reported from across North and South America.
NARA	National Archives and Records Administration	ROV	remotely operated vehicle
NOAA	National Oceanic and Atmospheric Administration	RSL	relative sea level
NSC	Non-Submarine Contact List, a database of shipwrecks, debris, seafloor pinnacles, and other features maintained by the NGA from U.S. Navy data.	RV	research vessel
NTL	Notice to Lessees and Operators, issued from BOEM on any number of topics.	SAI	Science Applications, Inc., consultant that prepared the previous Cape Hatteras to Key West study of the OCS for MMS.
NYSCCL	<i>New York Shipping and Commercial List</i>	SEAMAP	Southeast Area Monitoring and Assessment Program
OCS	Outer Continental Shelf (generally referring to the Atlantic Outer Continental Shelf)	SHPO	State Historic Preservation Officer
OCSLA	Outer Continental Shelf Lands Act, 1953 legislation that authorized the Department of the Interior to regulate and permit mineral leases on the outer continental shelf.	SNE-GB	Southern New England–Georges Bank
OSL	optically stimulated luminescence, a dating technique employing ionizing radiation to date geological sediments and some other mineral based materials.	SS	steam ship, designation used for commercial ships.
		SWATH	Small Waterline Area Twin Hull vessel
		USACE	U.S. Army Corps of Engineers
		USS	United States Ship, designation for commissioned ships in the U.S. Navy.
		U-Th	uranium-thorium, a radiometric dating technique used on calcium carbonate materials.

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SECTION 1 – INTRODUCTION AND BACKGROUND

1. INTRODUCTION

The sea is often described as the last great frontier. It is vast and opaque, and exploring its depths requires ingenuity and daring comparable to that summoned for space flight. The sea can be inhospitable and indifferent to human survival. From the vantage point of a ship far from shore, one can experience vistas of tremendous emptiness in every direction, with expanses of water meeting expanses of sky. Within this watery void, your ship is the only remnant of human culture as far as the eye can see—a floating outpost of cultural landscape. In this light, it can be difficult to imagine that the submerged continental shelf holds a rich archaeological record, documenting not just the history of maritime exploration, trade, and warfare in ships that never reached their ports, but thousands of years of prehistoric human settlement when sea levels were lower and coastlines were miles from the modern shore. This submerged archaeological record within federal waters along the Atlantic Seaboard is the subject of the current study.

The Atlantic Outer Continental Shelf (OCS) off the east coast of the United States extends from the Bay of Fundy in eastern Maine to Key West at the southern tip of Florida, and encompasses the area from the outside edge of state lands (established by the Submerged Lands Act of 1953 as 3 miles from the shoreline) out to the edge of the Exclusive Economic Zone (which stretches 200 miles offshore, except where such a distance overlaps with another nation's Exclusive Economic Zone). The Bureau of Ocean Energy Management (BOEM) has responsibility for permitting undertakings within such waters under the Outer Continental Shelf Lands Act (OCSLA), which was signed by President Eisenhower in 1953 and authorized the Secretary of the Interior to grant mineral leases on the outer continental shelf and create regulations necessary to carry out the provisions of the act (Austin et al. 2004:34). The Department of Interior assigned its OCSLA responsibilities in 1982 to the Minerals Management Service (MMS), now BOEM, giving it the authority to lease areas of the OCS for activities focused on oil and gas and non-energy minerals including sand and gravel (Environmental Law Institute [ELI] 2009:18). The Energy Policy Act of 2005 extended that authority to include offshore alternative energy development such as wind, solar, and hydrokinetic projects (ELI 2009:19).

The BOEM-permitted undertakings require consultation on cultural resource stewardship under the provisions of Section 106 of the National Historic Preservation Act. To better manage known and potential cultural resources, BOEM has requested an updated study for the Atlantic OCS that gathers information on historic shipwrecks and models the potential for prehistoric sites based on reconstruction of past landscapes, human settlement patterns, and site formation and preservation conditions, particularly during the period of coastal transgression. The current study supplements two previous studies of portions of the Atlantic OCS carried out approximately 30 years ago (Institute for Conservation Archaeology [ICA] 1979; Science Applications, Inc. [SAI] 1981). The ICA study covered the area from the Bay of Fundy to Cape Hatteras, while the SAI study covered the area from Cape Hatteras to Key West. Both studies provided an overview of the geology, prehistory, and sea level rise data that may affect submerged prehistoric site preservation, as well as a predictive model for locating historic shipwrecks. This study builds upon this body of work by exploring more recent research on prehistoric settlement patterns, archaeological research, and relative sea level curves to refine the predictive model for locating intact, submerged prehistoric archaeological sites on the OCS. It

supplements the research on historic shipping and shipwrecks by creating a database of known and suspected shipwrecks.

The goals of this study are two-fold. First, it sets out to evaluate current theories on prehistoric settlement patterns, paleoshoreline positions, relative sea level rise, and regional geology in order to identify potential areas on the Atlantic OCS where submerged prehistoric sites might be located. The second goal is to provide historic context for and construct a database of historic shipwrecks within the Atlantic OCS region. While the database has been provided under separate cover, this report documents the research involved in assembling the database, as well as an overview of historic shipping that provides context for the many submerged historic resources within the project area.

To tackle this investigation, characterized by sweeping geography and topical scope, TRC assembled a team of in-house and outside experts in history, prehistory, underwater archaeology, geoarchaeology, and marine geology from respected institutions across the East Coast. The product of the team's research is a database of historic shipwreck locations, accompanied by a summary of maritime history for the study area, and a presentation of current thinking on submerged prehistoric sites and the coastal landscape they occupied within what is now the Atlantic OCS, with expectations for where sites might be found and how to go about finding them. Each component of the study, along with an introduction of key concepts, is provided below.

1.1. PREHISTORIC PROBABILISTIC MODEL

The first component of the study involved evaluating current theories on prehistoric settlement patterns, paleoshoreline positions, relative sea level rise, and regional geology in order to identify potential areas on the Atlantic OCS where submerged prehistoric sites might be located. As part of this discussion, the TRC team provides information on state-of-the-art techniques and equipment that can be used to locate and investigate such sites.

The portion of the technical report presenting the model for submerged prehistoric sites draws on late Pleistocene/early Holocene site and settlement pattern information from terrestrial areas to establish “terrestrial analogs” for coastal areas submerged during the Holocene transgression. The limited available information on known submerged sites is also discussed. Important to the discussion is a consideration of what the coastline looked like at particular points in the past and how sea level rose in a given area. Recent research on paleolandscapes and sea levels is assembled for each region. The section contains a general discussion of potential site integrity in view of the nature of various types of landforms, how they might have changed during transgression, and taphonomy during and after inundation.

1.2. SHIPWRECK INVENTORY

The second component of the study consists of documentary and database research to identify confirmed, reported, and potential historical archaeological resources, centered on sunken vessels within the boundaries of the Atlantic OCS. The sources for this database included both primary and secondary sources from a large number of repositories, institutions, and agencies with an interest in maritime history. Available information about each wreck was

assembled into a Microsoft Access database to serve as a searchable tool that BOEM can use to identify known and likely historic sites within an area of concern. A geodatabase for all entries with coordinates within the Atlantic OCS also has been generated to work with ArcGIS.

The current shipwreck inventory used existing government and commercial databases. It built upon the data previously assembled, using additional primary historic sources, as well as secondary sources and commercial and governmental databases that catalog known shipwrecks and unidentified obstructions that could correspond to a historic wreck. The research on primary documents concentrated on sources with the highest potential to yield useful information, such as life saving station records, but other less productive sources were sampled as well—documents like newspapers, admiralty court records, and insurance claims. The quality of information contained in the records varied, both in terms of the location of the wreck and in the amount of historical detail and context about the ship and the circumstances of its demise. All of the information collected was entered into a database that referenced source information. That database is one of the primary deliverables for this study. As context for the shipwreck inventory, TRC's senior historian prepared a general, abbreviated maritime history of the Atlantic Seaboard, assembled information on vessel types, and offered a model for shipwreck potential across the OCS, as well as recommendations for survey strategies.

1.3. GEOGRAPHIC AND TEMPORAL DIVISIONS

Given the breadth of the Atlantic Seaboard, it is necessary to divide the OCS into smaller study regions to address the changes that occurred during both the prehistoric and geologic past (Figures 1.1 and 1.2 depict the temporal and spatial divisions referenced in this report). Any such divisions are, by their nature, arbitrary to a certain extent. Chapter 2, which provides an overview of the prehistory of the Atlantic Seaboard, uses divisions that follow the cultural and environmental differences noted in the archaeological literature. While it is obvious that prehistoric cultures did not recognize state boundaries, much of the research conducted along the East Coast has tended to follow such divisions, with similar projectile points sometimes having different names in neighboring states, for example. The discussion of prehistory is grouped into four parts: New England (encompassing Maine to Connecticut), the Mid Coast (encompassing New York to Virginia), the Southeast (the Carolinas and Georgia), and Florida. Certainly it is possible that one could group these areas differently, but these divisions provide a reasonable way to encompass what are broad areas of shared cultural patterns through the Paleoindian and Archaic periods, tied in some measure to environmental variables. The cultural history in Chapter 2 also focuses on two key temporal divisions: the Paleoindian and Archaic periods. Combined, these periods range from approximately 13,000 to 3,000 years ago, and encompass the limits of when human settlement would have been possible on the OCS, which varies region to region.

Section 2 of this report discusses current research on marine transgression and archaeological site preservation, and is also presented within a regional framework. These study regions are somewhat arbitrary, but they are employed here because they reflect a combination of geographical/geological distinctiveness and research histories. Chapter 3 focuses on the Gulf of Maine along the coast of Maine, which due to glaciation has a geologic history distinct from the Cape Cod and Georges Bank areas that are included in Chapter 4 (Southern New England and

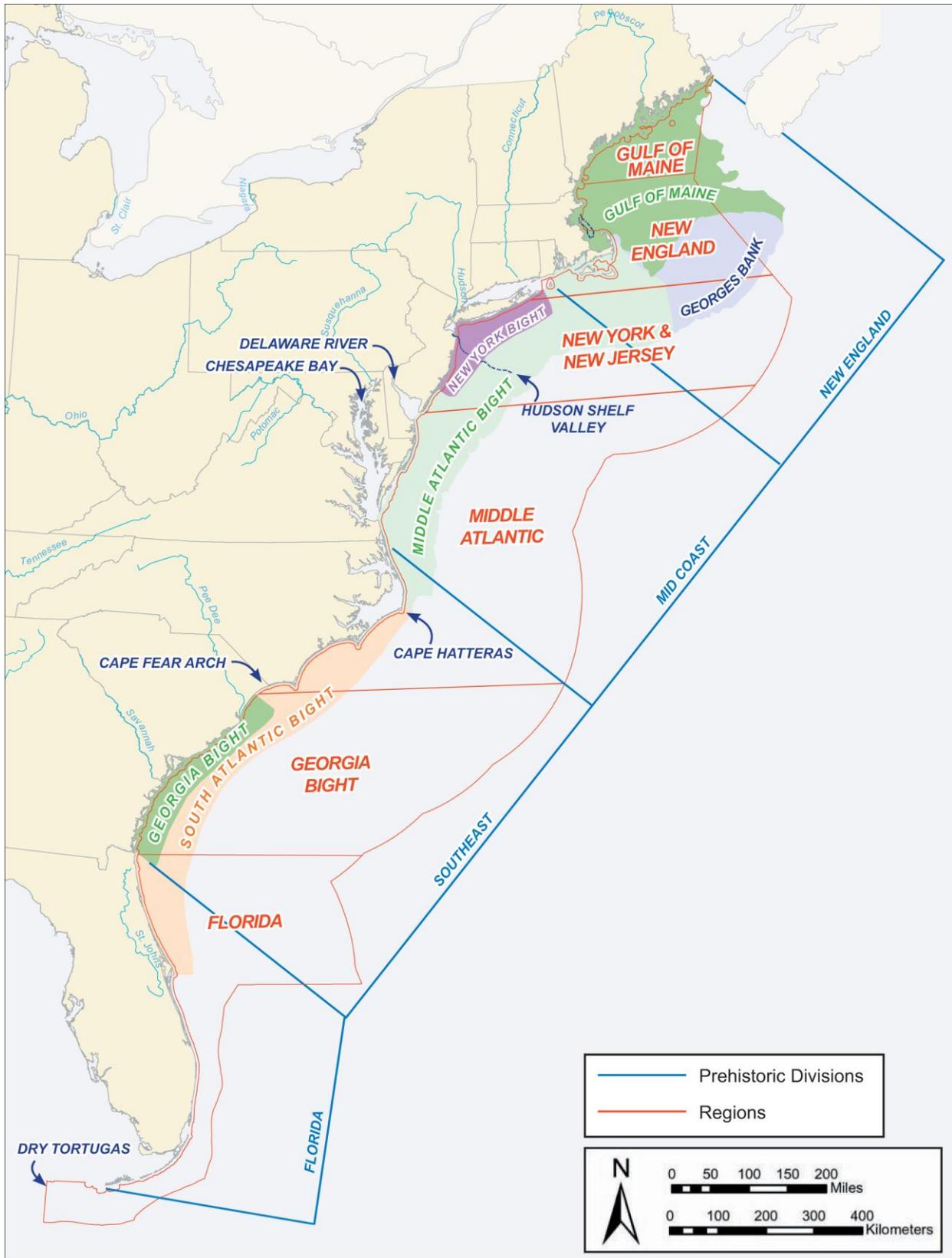


Figure 1.1. Prehistoric divisions and study regions used in this study.

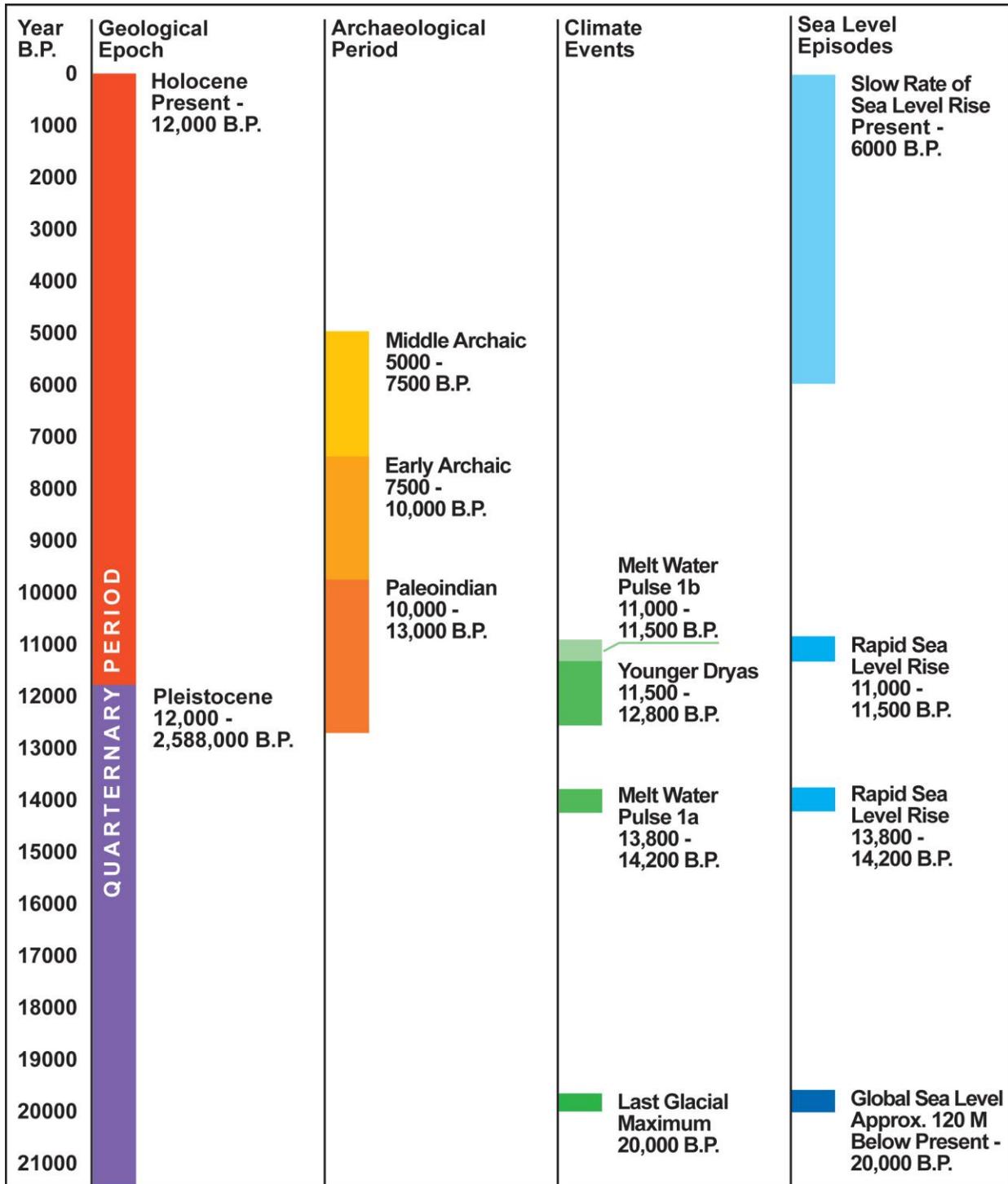


Figure 1.2. Chronological events associated with this study.

the Georges Bank). As one moves south from the Maine coast into Southern New England, larger areas of the now-submerged coastline were exposed during a time when human occupation was possible, unlike in areas further north. Chapter 5 includes the New York and New Jersey coasts, which encompasses the New York Bight, centered on the Hudson Shelf Valley. The next study region, the Middle Atlantic (Chapter 6), includes Delaware, Maryland, Virginia, North Carolina, and a portion of northern South Carolina. This region encompasses the Delaware and Chesapeake bays, the Albemarle Embayment in North Carolina, and the Cape Fear Arch. Chapter 7 examines the Georgia Bight, which extends from the vicinity of Myrtle Beach, South Carolina, to the Georgia–Florida border. Finally, Chapter 8 includes the coast of Florida from the Georgia border to the Dry Tortugas.

There is no consistency within the literature on the dating of certain geologic timeframes and events of interest in this study. For example, the maximum extent of the terminal glaciations in North America, referred to as the Last Glacial Maximum (LGM), is dated differently from source to source, anywhere from 17,000 B.P. to 22,000 B.P. The more recent literature, however, appears to cluster between 20,000 B.P. and 22,000 B.P. For example, Duncan et al. (2000:400) provide a date of 22,000 B.P., Otto-Bliesner et al. (2005:2526) indicate the LGM was at 21,000 B.P., Yokoyama et al. (2000) indicate the LGM was at 19,000 B.P., and McHugh et al. (2010) use 19,000–17,000 B.P. for the LGM. Given this range, a date of 20,000 B.P. has been adopted for the LGM in this report. LGM is an important point in time, since it represents a point of maximum subaerial exposure of the OCS. However, given the unlikelihood of human occupation of North America at this point (see Chapter 2), uncertainty about the precise date of the LGM has little possibility of negatively affecting site modeling on the OCS.

1.4. PALEOSHORELINES AND SEA LEVEL DETERMINATION FRAMEWORK

The Quaternary period has been a time of extreme and rapid climatic and environmental changes. Sea level fluctuation is a critical variable in reconstructing paleoenvironments, prehistoric settlement patterns, and subsistence patterns in North America (Murphy 1990). Such fluctuations represent the superposition of two independent movements, including that of the sea surface and that of the land surface (Dix et al. 2008).

The primary factors that influence global and regional sea level include changes in the volume of sea water, tectonics, and variations in the earth's gravitational field (Dorsey 1997). To a lesser extent, sea level changes reflect alterations in circulation patterns and thermal regimes. These factors can be classified in terms of their spatial extent (e.g., global versus local processes), their temporal extent (e.g., short term versus long term), or the medium in which they operate (e.g., vertical movements of the sea surface versus the vertical movements of the land surface) (Dix et al. 2008).

Over a time scale of millions of years, the primary factors that influence fluctuations in the global sea level consist of plate-tectonic-induced changes in ocean basin geometry. The long term movement of continental and oceanic crustal plates can result in changes of up to several hundred meters as ocean basins are created or destroyed and expand or shrink (Dix et al. 2008).

On time scales of tens of thousands of years, the periodic exchange of mass between the Earth's ice sheets and oceans as a result of glacial-interglacial cycles provides the dominant contribution. This includes both eustatic and isostatic components. Eustatic refers to changes in ocean volume and its distribution that are linked to changes in sea and terrestrial ice volume, while isostatic refers to changes linked to earth surface height, which reflect tectonism (rifting, uplift, etc.) and/or climate-driven changes such as ice volume and crustal loading. Isostasy is most often invoked in discussions of "isostatic rebound" after deglaciation, whereby the land mass that was depressed by the weight of glaciers rebounds or rises in adjustment as the glaciers melt and the weight is removed (Figure 1.3). Related to this process of isostatic rebound is subsidence along the margins of the former glaciated area, where the weight of the glaciated land surface would have created a forebulge. As the glaciers retreated, this forebulge would go through a process of subsidence. Thus, as the glaciers melted, glacial isostasy would involve uplift beneath the melted ice and subsidence along the rim of the melted ice. Figure 1.4 illustrates the correlation between sea level rise and various rates of rise or subsidence of the land connected with glaciation. In all cases, shorter term regional variations are superimposed on top of the longer term, global signature of sea level (Dix et al. 2008).

The main dynamic in global (eustatic) sea level is the change in the volume of oceanic waters in response to the cyclical growth and decay of the Earth's ice sheets. Essentially, the growth of the ice sheets removes water from the oceans and locks it up in glaciers, thus decreasing the global ocean volume. However, as glaciers retreat, glacial meltwater enters the ocean, increasing the volume (Dix et al. 2008). The mechanism for the growth and decay of glaciers throughout time has been attributed to changes in the orbital parameters of the earth, known as the Milankovitch cycle (Weaver 2002). While global oceanic waters were tied up in continental glaciers, vast areas of the now-submerged continental shelves worldwide were exposed.

Three primary categories of proxy sea level data can be used for reconstructing past landscapes: (1) global glacio-eustatic curves; (2) glacio-isostatic adjustment models; and (3) relative sea level curves (Dix et al. 2008). Relative sea level curves, obtained directly from past sea level indicators, such as dated corals, foraminifera, saltwater peat, intertidal oysters, or archaeological material, represent the most accurate way of reconstructing past coastlines for a particular region because they reflect the local impact of eustatic, isostatic, and tectonic variables (Dix et al. 2008).

The most recent full-glacial cycle began approximately 135,000 B.P. Global sea level and temperatures at that time were perhaps slightly higher than present levels (Donoghue 2006). Chappell and Shackleton (1986) derived Late Quaternary sea level curves from oxygen isotope data that demonstrate eustatic sea level fluctuations due to the expansion and melting of continental ice sheets throughout the past 135,000 years. Between 135,000 and 20,000 B.P., global sea level and temperatures fluctuated but generally fell, reaching the lowest point approximately 20,000 B.P. during the LGM. At this time, much of the world's water existed as ice in extensive glaciers that covered large land areas (Clark et al. 2009; Denton and Hughes 1981), and enough water was shifted to the continental glaciers to lower the world's oceans as much as 120–130 m (Clark et al. 2009; Dorsey 1997; Fairbanks 1989; Peltier 2005). This period during which sea levels were at their lowest is also referred to as the lowstand.

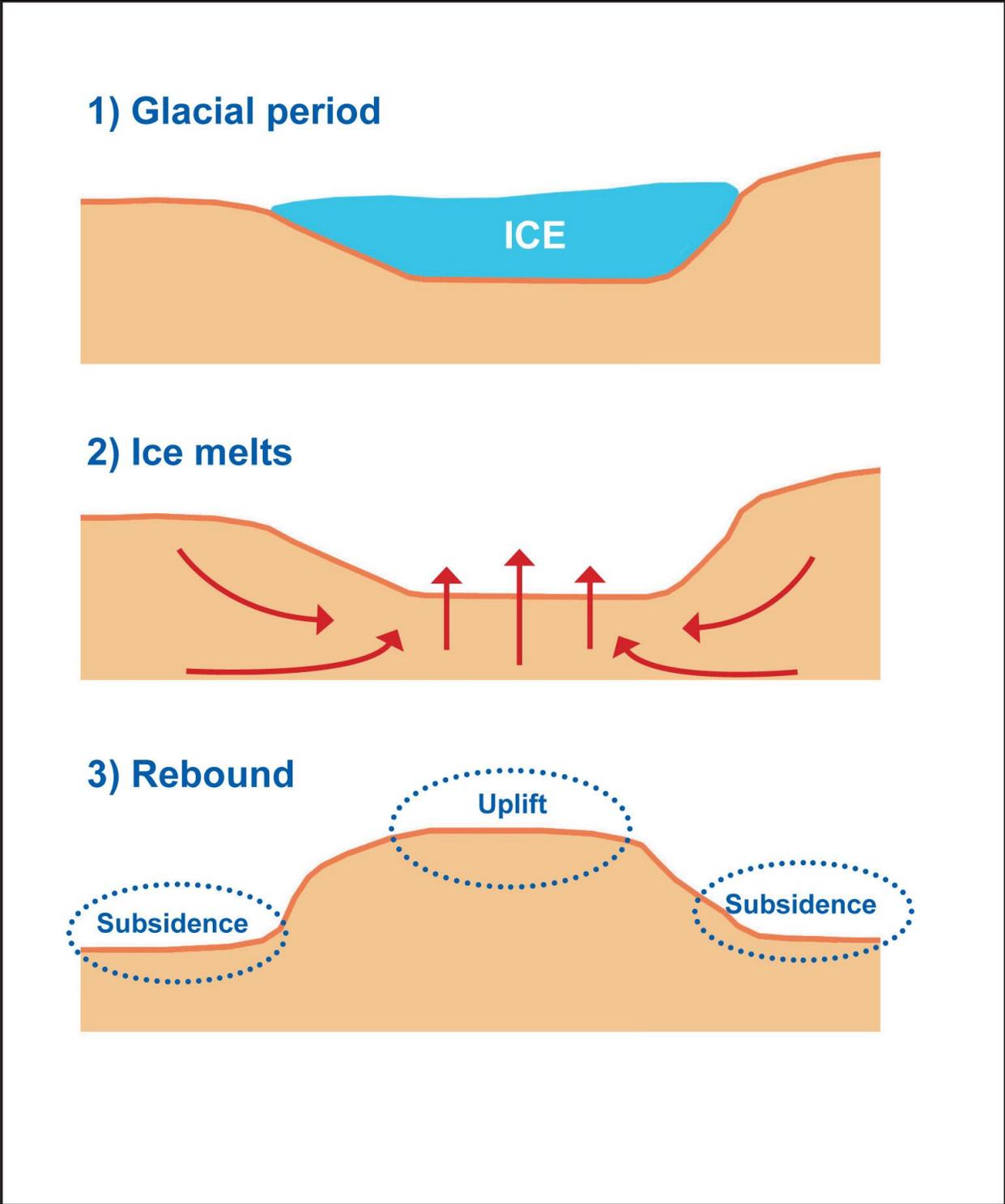
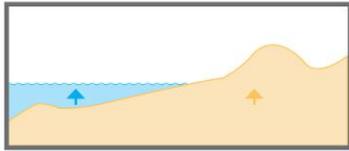


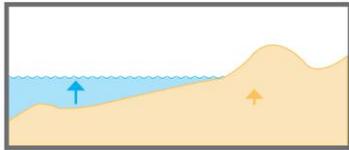
Figure 1.3. Illustration of isostatic rebound, whereby the land mass that was depressed by the weight of glaciers rebounds in adjustment as the glaciers melt and the weight is removed.

RELATIVE SEA LEVEL RISE



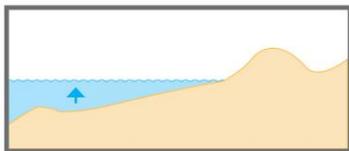
MODERATE TECTONIC UPLIFT OR ISOSTATIC REBOUND

Sea rises at the same rate as land, coastline does not change



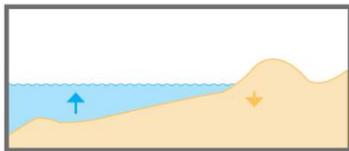
VERY SLOW TECTONIC UPLIFT OR ISOSTATIC REBOUND

Sea rises slightly faster than land, coastline slowly advances inland



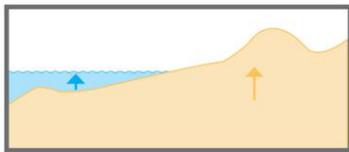
STABLE CRUST-EUSTATIC SEA RISE

Sea rises while land stays the same, coastline advances inland



TECTONIC SUBSIDENCE, SEDIMENT LOADING, OR GLACIAL BULGE SUBSIDIENCE

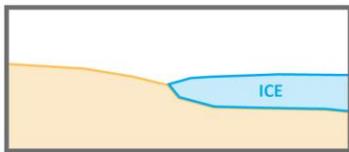
Sea rises while land subsides, coastline rapidly advances inland



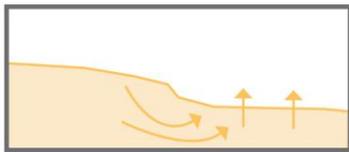
RAPID TECTONIC UPLIFT OR ISOSTATIC REBOUND

Land rises faster than sea, coastline retreats seaward, appearing to be falling locally, but actually rising eustatically

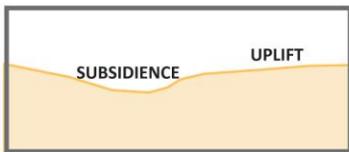
GLACIAL ISOSTASY



1: GLACIAL PERIOD



2: ICE MELTS



3: REBOUND

Figure 1.4. Factors influencing relative sea level rise.

Fairbanks' (1989) study of Barbados corals (*Acropora palmata*) yielded a detailed eustatic sea level record for the last 20,000 years. According to this record, sea level began to rise slowly around 20,000 B.P., following the LGM. As glaciers continued to retreat, global sea levels increased some 20 m from the LGM to 12,500 B.P., followed by a rapid period of sea level rise known as Melt Water Pulse (MWP) 1a, which Fairbanks dates to ca. 12,500–11,500 B.P. Sea rise slowed between 11,500–10,500 B.P., a period Fairbanks associates with the Younger Dryas, a period of cooling temperatures. This slower period of sea level rise changed abruptly with MWP 1b, a one thousand year period when sea levels rose approximately 28 m (Fairbanks 1989:639).

The dating of some of these events described by Fairbanks, however, has since been refined in some cases and questioned in others. For MWP 1a, Bard et al.'s (1990a, 1990b) uranium-thorium (U-Th) dating, combined with radiocarbon dates from Fairbanks (1989), provided a date range of (14,200–13,800 B.P.), with a corresponding sea level rise of 20 m (-94 to -74 m). Liu and Milliman (2004:187) suggest a slightly more narrow temporal range for MWP 1a (14,300–14,000 B.P.), representing a change in sea level of 20 m (for a mean rate of 66 mm/year), while Stanford et al. (2006) suggest a date range of ca. 14,100–13,600 for MWP 1a.

Perhaps more salient to this study is MWP 1b, which, unlike MWP 1a, corresponds to a period when humans were known to occupy North America. Bard et al.'s (1990a, 1990b) research indicate that MWP 1b took place from 11,500–11,100 B.P. and represents a change in sea level from -58 m to -43 m. Liu and Milliman (2004:187) present a similar assessment of MWP 1b, with a temporal range of 11,500–11,200 B.P., during which sea level rose from -58 m to -45 m (for a mean annual rate of 43 mm/year). Other scholars, however, have questioned the extent—and even the existence of—MWP 1b (see discussion in Montaggioni and Braithwaite 2009). The precise timing and amplitude of MWP 1b are still open questions for many because this event was originally detected as a hiatus between individual drill cores collected at different depths off Barbados, rather than being represented in a single core sample (Bard et al. 2010). In attempting to address the existence of MWP 1b, Bard et al. (2010) dated 47 pristine coral samples drilled onshore of the Papeete barrier reef in Tahiti using U-Th, but found no evidence of MWP 1b in these dated coral samples. Further research is necessary to resolve this issue, which has implications for archaeological site preservation potential.

Likewise, the dating of the Younger Dryas event has undergone some revisions based on more recent dating techniques. As Meltzer and Holliday (2010:8) note, “the most recent, high-resolution analysis—which uses isotopic analyses of deuterium excess and oxygen isotope 18 as indicators of past ocean surface and air temperatures, respectively—indicates that Younger Dryas cooling began 12,900 calendar years before present, with the warming starting 11,700 calendar years before present (Steffensen et al. 2008).” Until very recently, however, the archaeological literature has used a date range of ca. 11,000–10,000 B.P. for the Younger Dryas (e.g., Faught 2002, 2004; Mayewski and Bender 1995; Taylor et al. 1993).

Considering the revised efforts at dating these events, after ca. 11,000 B.P.—marking the approximate end of assumed MWP 1b—sea level rise again slowed. Sometime beginning 7000–6000 B.P., the net rate of sea level rise began to slow significantly and gradually approached its present rate (Dunbar et al. 1992; Oldale 1992; Stanley and Warme 1994).

1.5. COASTAL RESPONSE TO SEA LEVEL CHANGE

Coastlines are generally high-energy environments characterized by wave and tidal processes (Waters 1992). As a result, the preservation or destruction of sites on the coastline depends on the position of the site relative to shoreline processes (Coastal Environments, Inc. 1977; Gagliano et al. 1984). Depending on the interplay between a variety of factors including sediment supply, subsidence, coastal processes, and tectonic activity, shorelines have: (1) transgressed landward, (2) stabilized and maintained a neutral configuration, (3) prograded seaward, or (4) tectonically emerged or risen above the modern sea level (Waters 1992).

Paleoindian and Archaic period archaeological sites would have been affected by coastal processes during the last marine transgression. Transgression is primarily a destructive process that does not create ideal depositional sequences (Belknap and Kraft 1985). Episodes of transgression are periods of erosion. Consequently, the process of shoreline retreat is important for site preservation.

Transgression may occur in two ways: (1) by shoreface retreat, when the coastline slowly advances landward; or (2) by stepwise retreat, when in-place drowning of coastal features occurs (Waters 1992). Shoreface retreat is the erosion of previously deposited sediments by wave and current processes as the shoreline transgresses (Waters 1992). As sea level rose during the Late Quaternary, the beachface and shoreface erosion zones sequentially passed across those portions of the continental shelf that had been exposed. Thus, older sediments that had been deposited in coastal and terrestrial environments behind the shoreline were reworked, first by the swash and backwash processes and then by the waves and currents associated with the upper shoreface and breaker zones. Reworked terrestrial and coastal sediments are referred to as palimpsest sediments (Swift et al. 1972b), and the erosional surface, marking the depth of maximum disturbance by transgression, is known as the ravinement surface (Belknap and Kraft 1985). Shoreface retreat is most common in areas where the sea level rose slowly and subsidence rates were low.

A major factor determining the severity of erosion during shoreface retreat, and as a consequence the preservation potential of Late Quaternary sediments and any contained sites, is the rate at which sea level rises (Belknap and Kraft 1981). If the sea level rises rapidly over the continental shelf—for example, during meltwater pulses—erosion will be of relatively short duration and the underlying sediments will have a greater potential for preservation (Waters 1992). However, a rapid rate of sea level rise is not a necessary condition for potential site preservation. During periods of steady sea level and even retreating water (e.g., during the Younger Dryas), identifiable beaches and shallow water features such as wave-cut terraces or oyster bars can be produced and occasionally preserved (Hine 1997). More important archaeologically are those preserved terrestrial or fresh water features indicative of the actual Pleistocene landscape inhabited by the early human arrivals. Such features can include buried river and stream channels, karst features and more developed sinkholes, in-place soils, peats, tree stumps, higher elevation rock outcrops, and other similar landform features.

More important than sea level rise in the potential for site preservation is the configuration of the topography on the continental shelf prior to transgression (Belknap and Kraft 1985). If a site is located and later buried in a topographic position that will not be eroded during transgression, it will be preserved under the ravinement surface.

Other factors that influence site preservation on the continental shelf include: (1) the energy level of the coastal processes and depth of the wave base; (2) the cohesiveness of the sediments comprising the site matrix; (3) the amount of subsidence prior to transgression; (4) the gradient of the continental shelf; (5) tidal range; and (6) sediment import and export processes (Waters 1992).

1.6. ARCHAEOLOGICAL SENSITIVITY FOR PREHISTORIC SITES

This report employs two ways of characterizing the likelihood that portions of the OCS have preserved prehistoric resources. The first method uses the term “sensitivity” and addresses physical and culture-history constraints on site formation. Under this approach, sensitivity is constrained by when prehistoric occupation was first possible and then likely, and is geographically defined by reference to sea level curves used in each region that correspond to these temporal events. This approach divides the OCS in each region into three sensitivity categories, as described below:

1. No Sensitivity: Areas that were not subaerial at the LGM. Since such areas were always submerged, they have no potential for containing terrestrial sites.
2. Low Sensitivity: Areas that were subaerial between the LGM and the Paleoindian period, representing a time when it is unlikely—although possible—that human settlement of eastern North America existed.
3. High Sensitivity: Areas that were subaerial beginning with the Paleoindian period to the present.

The second method of characterizing the likelihood of preserved prehistoric sites uses the concept of preservation potential. Areas of High Preservation Potential represent locations within the High Sensitivity areas where conditions exist that provide a better likelihood that prehistoric sites would have survived marine transgression. In some regions, there may be no specifically known or mapped High Preservation Potential areas designated, although characteristics that would define such areas (hence, provide the conditions that surveys would attempt to identify) are provided. Throughout most of the OCS, detailed studies of geomorphology using seismic sub-bottom profiling and coring in conjunction with bathymetry are needed to define the character of submerged landforms and create more fine-grained mapping of potential intact site settings. Over time, such information may become available for more areas—perhaps in part through investigations prompted by offshore energy development—and mapping of High Preservation Potential areas can be refined.

1.7. REPORT STRUCTURE

This report is divided into four sections, each containing thematically-related chapters. Section 1 includes this introduction (Chapter 1) and an overview of the prehistory of the Atlantic Seaboard (Chapter 2). Section 2 contains Chapters 3–8, which are contributions to current research for different areas within the project area, from Maine to Florida. Drawing on Sections 1 and 2, Section 3 synthesizes the prehistoric modeling introduced in the regional chapters (Chapter 9) and presents proposed survey methods for identifying locations for prehistoric sites

(Chapter 10). Finally, Section 4 covers work to develop the Atlantic OCS shipwreck database, including a discussion of sources and methods for research (Chapter 11) and a historical overview of shipping on the Atlantic Seaboard (Chapter 12).

2. PREHISTORIC SETTLEMENT PATTERNS

2.1. INTRODUCTION

Despite decades of archaeological research, our understanding of the earliest humans to occupy what is now the eastern coast of the United States remains limited. The earliest, most broadly acknowledged human presence in the continental United States dates to approximately 12,500 B.P., during the Paleoindian period. The most well-known cultural manifestation of this early settlement is called Clovis, which is represented archaeologically by distinctive, fluted projectile points that have been found over a wide geographic area in the United States. However, for decades there have been sites that indicate, if not conclusively prove, a pre-Clovis occupation in the Americas; these include Meadowcroft Rockshelter, Pennsylvania (Adovasio et al. 1990, 1998, 1999); Saltville, Virginia (McDonald 2000; Wisner 1996); Cactus Hill, Virginia (McAvoy and McAvoy 1997); the Topper site in South Carolina (Goodyear and Steffy 2003); and the Sloth Hole and Page-Ladson sites in Jefferson County, Florida (Dunbar 2002, 2006a; Hemmings 1999, 2004). None of these sites is without controversy, but they have forced archaeologists to revisit their models for how and when people first arrived in the Americas (e.g., Anderson and Gillam 2000).

Most archaeologists accept that the human occupation of North America began with a migration of people from Asia across the Bering land bridge, which would have been exposed from 20,000 B.P. to a time perhaps as late as 10,000 B.P. due to lower sea levels associated with the LGM (Anderson and Gillam 2000; Dixon 1999, 2001; Fladmark 1979; Hoffecker et al. 1993:48; Meltzer 1988, 2004; Smith 1986). Once in North America, the method and timing of migration south into the Americas remains an issue of debate. Some researchers have argued that an ice-free corridor allowed for movement into the interior of the continent sometime after 11,000 B.P. (e.g., Haynes 1966, 1969, 1971), while others have suggested that early settlers, once having occupied Beringia, followed a coastal route to colonize the Americas (e.g., Dixon 1999; Faught 2008; Fiedel 2000; Fladmark 1979).

Given the fact that sites that might confirm a coastal migration are almost certainly now inundated, it may be impossible to demonstrate which route accounts for the settlement of the continent. However, researchers have evaluated models of migration by testing them against those data that are available. For example, Goebel et al. (2008) present a working model to explain the origins of human occupation of the Americas that draws on both genetic and archaeological evidence. They first summarize the results of genetic testing of contemporary Native American populations, including nuclear gene markers, mitochondrial DNA (mtDNA), and Y chromosomes, which demonstrate a genetic connection to contemporary, indigenous populations of southern Siberia (Goebel et al. 2008:1497). DNA tests conducted on early skeletal remains and human coprolites also support an Asian origin. Interestingly, analysis of genetic variation in contemporary Native Americans, particularly certain subclades of mtDNA found in Native American groups throughout North, Central, and South America—but not in Asian populations—suggests common American ancestors approximately 16,600–11,200 B.P. (Goebel et al. 2008:1498).

Fix (2002) has noted that the mtDNA data make it difficult to accept the notion of Clovis people migrating south from Beringia through the ice-free corridor and spreading rapidly throughout the Americas (cf. Martin 1973), since the timing of such a passage would have been too late to account for the genetic variability observed. He notes that a model of coastal migration, which presumably would have allowed for an earlier start of settlement (perhaps as early as 16,000 years ago) is consistent with the genetic variability in contemporary Native American groups throughout the Americas (Fix 2005). This settlement model assumes that people moved down the Pacific coast to the narrow isthmus of Central America, crossed the isthmus, and continuing to spread up the Gulf and Atlantic coasts, with the Mississippi River serving as an entry to the continental interior (Fix 2005:432). Based on this model, the Eastern Seaboard of North America could have been settled within 3,000 years (Fix 2005:432–433).

Others have suggested that Clovis derived not from Asia, but from the Upper Paleolithic Solutrean culture of Europe, which dates to ca. 22,000–16,500 years ago (Bradley and Stanford 2004:465; Sellet 1998). Noting that there are no known pre-cursors to Clovis in Alaska or eastern Asia, they suggest Solutrean maritime hunters entering the Atlantic coast of North America may account for the handful of early, pre-Clovis sites on the Eastern Seaboard. They point to a number of factors to support their hypothesis, including similarities in tool manufacturing techniques and artifact forms between Solutrean and Clovis tools, temporal consistency, and a plausible migration route to North America.

The logistical problems a founding population would have encountered traversing the North Atlantic Ocean, the lack of early occupation sites above about 48 degrees north latitude, and a gap of at least 5,000 years between Solutrean sites in Iberia and early sites in eastern North America, suggest that any resemblance in bone and lithic tools between the two cultures is coincidental, and not indicative of direct contact (Straus 2000; Straus et al. 2005). Furthermore, genetic data also indicate an Asian origin for Native American populations (Fix 2005; Straus et al. 2005:522–523). Still, should the North Atlantic migration route be shown to have been viable, the continental shelf off the northeastern U.S. would be a logical place to search for evidence (Stright 2004).

One study of Paleoindian settlement patterns resulted in a model to explain “routes, rates, and reasons” (Anderson and Gillam 2000:43) for colonization of the Western Hemisphere. The study analyzed paths at a continental scale, to determine which routes would have afforded the least cost to traveling hunter-gatherers. Factors in the model included topographic relief, locations of ice sheets and pluvial lakes, and the location of known Paleoindian archaeological sites. The findings suggest that initial dispersal occurred in coastal and riverine settings and on plains, and that founding populations probably spread and diversified rapidly. In terms of routes, Anderson and Gillam’s model implies that now-submerged portions of the continental shelf may have been important for early dispersal, whether by foot or by boat. In eastern North America, this is reflected in the distribution of sites along the Atlantic Coastal Plain and the paucity of sites in the Appalachian Mountains, which were a barrier to mobility.

One of the challenges of any of these models of population spread into the Americas is accounting for sites that appear to predate Clovis. While none of the referenced North American sites is universally accepted by scholars, the finds at Monte Verde, Chile, appear to have convinced most skeptics (Meltzer et al. 1997). The earliest securely dated Paleoindian stratum at

Monte Verde dates as early as ca. 13,800 B.P. (Dillehay 1989), so models that cannot explain outliers such as this site are problematic.

What is known about the early occupation of the Eastern Seaboard derives not from models, but empirical data from field research up and down the coast. The following sections present summaries of that early settlement, including the Paleoindian and Archaic periods—periods when settlement of the OCS was feasible, based on what is known about Late Pleistocene/Early Holocene sea levels along the Atlantic coast. The dates for these periods vary up and down the coast, based on the extent to which dated contexts are available. As a general framework, the Paleoindian period dates roughly from 13,000–10,000 B.P., while the Archaic period ranges roughly from 10,000–3,000 B.P. Regional culture histories below refine these date ranges, as appropriate. All dates presented here, unless noted otherwise, are given as uncalibrated years before present (B.P.).

Drawing geographic lines to demarcate areas of culture history has always been a challenge. Not only is one faced with cases of gradual material culture variation that must be geographically parsed, but it is also necessary to take into account thousands of years of cultural developments in which cultural expressions and affiliations emerge differentially across space and time. Further complicating the task, regional similarities in prehistoric developments have been masked to some extent by typological nomenclature influenced by where research has been conducted and the spheres in which researchers operate, often following state boundaries. The following geographic divisions have been defined to encompass broad areas of shared cultural patterns through the Paleoindian and Archaic periods, tied in some measure to environmental variables. Section 2.2 focuses on New England, including Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut, where similar climate and environmental conditions correspond with broadly similar cultural developments. Section 2.3 covers a larger geography that encompasses coastal New York, New Jersey, Delaware, Maryland, and Virginia. This area was populated by prehistoric groups whose archaeological record is more similar internally than to regions north and south. While archaeologists would refer to most of this region, with the possible exception of New York's Long Island, as the Mid-Atlantic, no geographic name effectively encompasses these states. Therefore, to avoid any confusion, the current report refers to this area as the Mid Coast region. Section 2.4 discusses the prehistory of the Southeast, which for purposes of this study includes North Carolina, South Carolina, and Georgia, which generally follow the same patterns of prehistoric developments and display the same types of material culture. Finally, Section 2.5 includes the culture history of peninsular Florida. All of the sites mentioned in the text are plotted in Figure 2.1.

2.2. NEW ENGLAND

Archaeologists have documented over 12,000 years of human settlement in the terrestrial terrain of New England. The archaeological record of ancient Native American habitation in the Northeast is commonly divided into three general temporal periods: Paleoindian, Archaic and Woodland. A —Late" period is sometimes included in discussions about the Paleoindian period, and the Archaic and Woodland periods are both further subdivided into Early, Middle and Late categories. In addition, the Late Archaic and the Early Woodland periods are separated

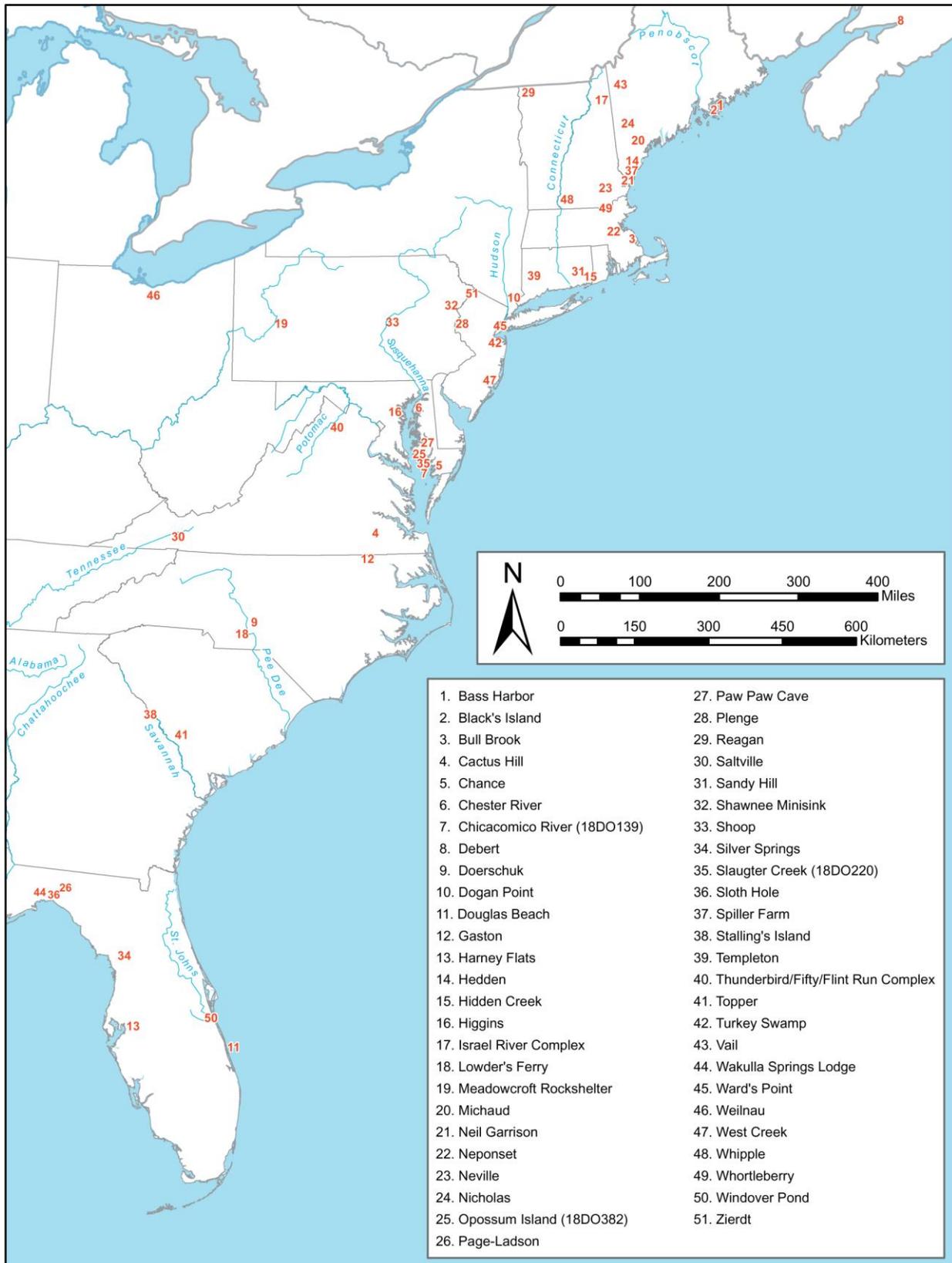


Figure 2.1. Locations of sites mentioned in this section.

by a distinct transitional period referred to as the —Transitional” or the —Terminal” Archaic. Each division among the general periods of the ancient Native American cultural chronology is based on the interpretations of the archaeological record. These periods are distinguishable within the archaeological record on the basis of observed differences in the material culture, specific land use patterns inferred from the archaeological remains of the material culture, and, occasionally, by other indicators, such as mortuary practices.

The ancient Native American cultures of the early pre-contact period corresponding with the ca. 12,500–6000 B.P. period, when portions of the region were subaerially exposed and available for human habitation include:

- Paleoindian period (ca. 12,500–10,000 B.P.)
- Early Archaic period (ca. 10,000–7500 B.P.)
- Middle Archaic period (ca. 7500–5000 B.P.)

Up until a little over a decade ago, ancient Native American artifacts and/or documented archaeological sites dating from the Paleoindian and Early and Middle Archaic periods along the coastal plain were quite rare. This lack of archaeological data initially led archaeologists of the 1960s to conclude that the Northeast’s “closed boreal forests” of the post-Pleistocene could support few human foragers, and that these unfavorable environmental conditions had resulted in an apparent depopulation of the Northeast at that time (i.e., known as the —Ritchie-Fitting hypothesis”) (Fitting 1968; Ritchie 1980). The Ritchie-Fitting hypothesis was confronted with newer palynological data that indicated that the environment of New England, especially southern New England, was more amenable to habitation than had been suggested previously, and the Ritchie-Fitting hypothesis has since been rejected (Dincauze and Mulholland 1977; Jones 1998; Robinson and Petersen 1992).

While sites dating from the Paleoindian and Early and Middle Archaic periods remain rare compared to later Woodland Period sites along the Atlantic Coastal Plain, archaeological investigations in southern New England in the last 25 years have dramatically increased our existing knowledge about ancient Native American settlement patterns and resource procurement strategies (Carr 1996; Cross 1999; Doucette and Cross 1998; Dunford 1999; Forrest 1999; Gardner 1987; Jones 1998; Jones and Forrest 2003). These archaeological data indicate that there was a complex transition of cultures from the time of the arrival of the first Paleoindian colonists to the florescence of the Middle Archaic populations some 3,000 years later (Jones 1998). These studies also have brought into question the adequacy of current terrestrial archaeological survey paradigms for locating sites from these periods in New England. Jones (1998) has opined that limitations of archaeological testing strategies commonly used on land in the Northeast have biased the current record of Paleoindian and Early Archaic sites towards medium to large interior camps—sites that are probably not representative of the range of site types produced by hunter-gatherers of the terminal Pleistocene and early Holocene.

The rapidly changing environment that characterizes the late Pleistocene to early Holocene time period hypothetically should have produced an archaeological record of site types that is highly variable, because of the need for flexible responses in social and economic behavior to the

environmental conditions (Jones 1998). Increasingly, evidence of lowered water levels and an emergent correlation between large wetlands and major water bodies and ancient Native American archaeological sites suggests that water (inland and coastal) and its associated food resources were critical factors in site selection. Hypotheses are now proposed that assert large Early and Middle Archaic period archaeological sites in proximity to large lakes, rivers and extensive wetlands with inlets and outlets flushing their respective systems may have been more common on the Coastal Plain, but were submerged by the rising sea level (McWeeney and Kellogg 2001). It is perhaps for this reason that certain site types (especially large coastal occupations and very small interior camps and extraction locations) seem to be lacking or are very rare in the archaeological record (Jones 1998). With very few exceptions, virtually all documented Paleoindian and Early Archaic finds reported throughout New England lack detailed contextual information.

2.2.1. Paleoindian Period

Following the retreat of thick glacial ice, the present terrestrial landscape, as well as the then-subaerially exposed portions of the OCS in New England, were probably inhabited by a relatively low population of mobile hunter-gatherers employing a specialized tool kit developed for the exploitation of large migratory game (e.g., caribou, elk, bison, and mastodon) (Dragoo 1976; Kelly and Todd 1988; Snow 1980; Waguespack and Surovell 2003). In particular, Paleoindian people living in the region are thought to have relied mainly on caribou that presumably were abundant in the environment of that time (Spiess et al. 1998). The presence of these early inhabitants is recognized in the archaeological record through distinctive lithic technologies.

The Paleoindian period in the Northeast is divided into two temporal groupings, or traditions. Diagnostic fluted projectile points and related artifacts characterize sites of the Fluted Point Paleoindian Tradition (12,500–10,050 B.P.) (Spiess 1990; Spiess et al. 1998). The elongate, bifacial points have a distinctive flake scar, or flute, created by the removal of a channel flake from one or both faces of the tool (Snow 1980). Other characteristic artifacts include unifacial endscrapers, usually made from a single flake with a spur, or graver, on one or both ends (Snow 1980; Spiess et al. 1998). *Pièces esquillées*, created from thick flakes or core fragments, are also typical of the Paleoindian tool kit (Snow 1980). The Late Paleoindian Tradition (10,050–9,500 B.P.) is distinguished by a change in bifacial technology from fluted points to parallel-flaked lanceolate points, similar in form to Scottsbluff or Eden points of the Midwest and western U.S. (Cox and Petersen 1997; Doyle et al. 1985; Spiess et al. 1998; Will and Moore 2002).

Throughout the Paleoindian period, artifact assemblages tend to feature non-local lithic materials, such as chert and jasper and regionally and extra-regionally available rhyolites (e.g., Mount Jasper rhyolite, Lynn volcanic suite, Saugus Jasper, Munsungun Formation chert, etc.). A marked preference for fine-grained crystalline material is reflected Paleoindian lithic technology. Raw materials observed in artifacts recovered from sites in New England include chert, chalcedony, jasper, quartzite, crystal quartz, and fine-grained volcanic rocks, such as rhyolite and felsites, often found hundreds of kilometers from their primary source (Spiess et al. 1998). These great distances may represent long distance travel to established source areas, trade, and/or utilization of fluvially or glacially transported material.

Recognition of a variation in point styles has led to the establishment of a typology and chronology for regional Paleoindian fluted points. Spiess and others (1998) developed a four-part typology, while Dincauze's (2007) analysis produced a slightly different division. Both schemes use the Great Lakes region typology as a basis (see review by Ellis and Deller 1997) for New England divisions. The sequences are based on variations in the length/width ratio of the projectile, size and shape of the basal concavity, size of the flute scar, and the presence or absence of "fishtail" forms at the base of the point. Chronology was established using radiocarbon dates, when possible, and relative position on lakebeds and stepped shorelines in the Great Lakes. Each phase is named for the site whose artifacts best represent the type's attributes.

In New England, Spiess et al. (1998) recognize the oldest phase as the Bull Brook/Vail-Debert, named for the fluted point types recovered from the Bull Brook site in Massachusetts, the Vail site in Maine, and the Debert Site in Nova Scotia. This point style is parallel-sided to lanceolate in shape with a medium to deep basal concavity, and flute scars that extend along half the length of the point (Spiess et al. 1998). The phase is dated at a number of sites across New England and Nova Scotia, and represents the time period from 10,800–10,500 B.P. (Spiess et al. 1998). Dincauze (2007) lists Bull Brook as the oldest period, comparable to the Gainey phase of the Great Lakes, with Vail-Debert as stylistically different, but also representing the initial Paleoindian occupation of the region.

The next youngest Paleoindian phase in Spiess et al.'s (1998) typology is the Michaud-Neponset, and it is best characterized by points from the Michaud site in Maine and the Neponset site in Massachusetts. These points are narrow and thinner than those of the preceding phase, and have a flute scar that extends along most of the entire length of the tool (Ellis and Deller 1997). The basal concavity is shallow, and the base is typified by "fishtails" or "flange ears" (Spiess et al. 1998). This style is similar to the Barnes points of the Parkhill Phase of the Great Lakes and Mid-Paleoindian of the Mid-Atlantic. The Michaud-Neponset phase is associated with dates close to 10,700–10,300 B.P. (Spiess et al. 1998). Dincauze (2007) uses essentially the same styles, but names the phase Barnes/Parkhill/Neponset.

Crowfield Phase points occur in both the Great Lakes and New England, and are correlative with Simpson points of the Mid-Atlantic (Spiess et al. 1998). These points are thinner and wider than Michaud-Neponset phase artifacts, and expand from a narrow base (Ellis and Deller 1997). They often have multiple, long flutes and a shallow, wide basal concavity (Spiess et al. 1998). These points have been found in Vermont and eastern Massachusetts. No Crowfield Phase dates are available for New England.

The youngest New England fluted point type is the Nicholas, named for the Nicholas site in Maine (Spiess et al. 1998; Wilson et al. 1995). These points are similar to those from the Holcombe phase of the Great Lakes region, and are small and thin with shallow concave bases (Spiess et al. 1998). A Nicholas Phase site in Maine has yielded dates of 10,060 B.P., and is thought to provide "reasonable end-date for fluted point Paleoindian occupation in the region" (Spiess et al. 1998:238). This conclusion is further supported by the discovery of another Nicholas phase site in interior Maine, which yielded an Accelerator Mass Spectrometry (AMS) radiocarbon age 10,110 B.P. (Will et al. 2001). Dincauze (2007) groups the Crowfield and Nicholas/Holcombe phases with lanceolate points as Terminal Pleistocene and Early Holocene. Anderson (2001:155) suggests that the replacement of lanceolate points with notched projectile

points in the Late Pleistocene/Early Holocene coincides with a shift in hunting emphasis from large animals to –smaller, more dispersed game animals.”

Paleoindians were once thought to be highly specialized hunters of big game, such as mammoths, mastodons, and caribou. Archaeological data from Paleoindian sites throughout New England (Meltzer and Smith 1986; Spiess et al. 1998) and the ecologically similar Great Lakes (Stothers 1996) region are consistent with the hypothesis that Paleoindians subsisted on migratory game, chiefly caribou. Paleoindian sites in New England have yielded caribou, beaver, and bison bones, along with some charred floral remains including nuts and berries (Spiess et al. 1998). Specialized subsistence models focusing on large game derive primarily from Paleoindian sites located in the midwestern and southwestern United States, such as the Folsom site (Figgins 1927), which clearly exhibit evidence for the exploitation of large (now extinct) animal species by humans. However, recent evidence suggests that an emphasis on large game may be overplayed, and that Paleoindians across North America were more likely opportunistic hunters and gatherers whose diet was largely influenced by environmental variability (Cannon and Meltzer 2004; Meltzer 1993). Similar arguments have been made by researchers in the Northeast (Dincauze 1993; Ogden 1977). Dincauze (1990) has asserted that the Paleoindian inhabitants of southern New England made use of the full range of readily available plant and animal species that existed at the time. Jones and Forrest (2003) have also argued for the more generalized subsistence model among Paleoindian peoples, citing the apparently higher occurrence in the archaeological record of small Paleoindian encampments as compared to that of larger base camps in the region. They assert that these smaller sites reflect a settlement system wherein small groups of mobile foragers adapted to resource unpredictability and pursued a more generalized subsistence regime, exploiting a variety of available floral and faunal resources present in the resource-rich areas surrounding freshwater glacial ponds and wetlands widely distributed across the recently deglaciated New England landscape. Archaeological evidence recovered during the excavation of Shawnee Minisink archaeological site, situated along the upper Delaware River, seems to support Dincauze, Jones and Forrest’s arguments for Paleoindian exploitation of a broad subsistence base, as it includes evidence for the processing of fish, nuts, and edible plants (e.g., Goose foot [*Chenopodium* sp.], ground cherry, black berry, hawthorn plum, pokeweed, pigweed [*Amaranthus* sp.], smart weed [*Polygonum* sp.], wild lettuce, grape, hackberry, and meadow grass) (Hanley et al. 2002).

While no evidence of sea mammal hunting by Paleoindian-period peoples has been found in the archaeological record to date, the possible exploitation of sea mammals by Paleoindians in the Northeast should not be ignored, as they are an important resource for many arctic and sub-arctic peoples today (Jones 1998). Finds of the archaeological remains of marine mammals on the former shores of the Champlain Sea in Vermont, and the serendipitous recoveries of mammal finds from the continental shelf by fishermen, indicate that marine mammals such as walrus, ringed seal, harp seal, bearded seal, hooded seal, harbor seal, and gray seal all could have been present and exploited by coastally-adapted Paleoindian settlers (Jones 1998).

Generally, settlement strategies during the Paleoindian period are poorly understood as Paleoindian materials and sites are, overall, quite rare in the documented archaeological record. However, it is clear that Paleoindian site size and duration of occupation are highly variable (Jones 1998). Identified sites include large, possibly seasonally occupied base camps such as the Vail site in Maine and the Bull Brook site in Massachusetts; small residential camps such as

Reagan in Vermont, Whipple and Israel River complex sites in New Hampshire and the Templeton site in Connecticut, as well as very small task-specific loci, such as the Hidden Creek site in Connecticut (Basa 1982; Boisvert 1998; Bouras and Bock 1997; Byers 1954; Gramly 1982; Jones 1997; McWeeney 2002; Moeller 1984; Robinson et al. 2009; Spiess et al. 1998). In some areas, Paleoindian sites have been found in settings removed from present-day water bodies but on landforms strategically positioned above low-lying terrain that may have been suitable habitat for caribou and other game animals; campsites in such settings are typically indicative of short-term habitations by small groups of people, perhaps in some cases by even a single, extended family (Spiess et al. 1998). Elsewhere, a strong correlation has been found between Paleoindian sites and glacial features that include well-drained sand and gravel kame deltas and outwash terraces, suggesting a preference for high, well-drained ground, near streams or wetlands, which also offered vantage points for observing game. In the coastal region of Maine, for example, the pattern of small Paleoindian sites on sandy high ground near water sources is embodied in the Hedden (Spiess and Mosher 1994; Spiess et al. 1995; Spiess et al. 1998), Spiller Farm (Hamilton and Pollack 1996), and Neil Garrison (Douglas Kellogg, personal communication 1999) sites. Two small, eroding sites on the coast at Boothbay contained Paleoindian artifacts eroding from beneath Ceramic period shell middens (Spiess et al. 1998). While now at the present-day coast, at the time of Paleoindian occupation, the site was located inland, adjacent to a stream. Work by Kelley (2006) suggests that in inland Maine, a region dominated by lakes and wetlands during the late Pleistocene and early Holocene, hunting and travel sites would be associated with lake/wetland shores and thoroughfare locations between lakes. The limited size and artifact suites of these sites has been used to identify each as a travel or hunting campsite, used by a few people for a short amount of time. The linkage between geomorphic features and archaeological sites has been used to suggest hunting strategies (Spiess et al. 1998), but may also suggest the importance of locating water during drier periods. McWeeney and Kellogg (2001) suggest that people of this time relied more heavily on upland regions where thinner glacial sediments and bedrock control of groundwater made water availability at springs and streams more predictable.

The large Paleoindian sites known from New England and Nova Scotia are each characterized by eight or more artifact loci, reflecting population aggregation and/or repeated site visits (Robinson et al. 2009). For example, the Bull Brook site, located in Massachusetts, is positioned on a large, flat-topped sandy kame or delta, and is composed of a circular pattern of 36 loci (Byers 1959; Robinson et al. 2009). Robinson et al. (2009) interpret the site as an aggregation site for communal hunting to exploit the seasonal movement of caribou from subaerially exposed portions of Jeffreys Ledge to the inland ca. 10,300 B.P. Likewise, Vail, in northwest Maine and now submerged by Azischohos Lake, is interpreted as a riverside kill site (Gramly 1982). Large sites like these have produced the vast majority of fluted points recorded in New England in the Paleoindian Database of the Americas (PIDBA), an online, county-by-county (or province) database of Paleoindian period projectile points finds in North and South America (PIDBA 2009).

It is probable that many Paleoindian sites were situated on the now inundated continental shelf (Marshall 1982). The existence of submerged Paleoindian sites has been revealed by the finds of scallop draggers. For example, the dredges on a scallop dragger off the western tip of Black's Island in Maine's Blue Hill Bay recovered three Late Paleoindian lanceolate bifaces from approximately 44 m water depth (Crock et al. 1993). Examination of bathymetric charts

from the region suggests that the artifacts may come from a site or sites located near the edge of the now submerged Union River channel (Crock et al. 1993). These artifacts represent the oldest recovered material from Maine waters. While indicative of occupation during the Late Pleistocene/Early Holocene, it is unlikely that these artifacts were recovered from an intact site. More reasonably, they represent material eroded from what was then a terrestrial site located on the Union River banks, and redeposited into the river channel nearby. Kelley et al. (2010) describe a submerged site in inshore waters near Bass Harbor, Maine that is associated with Middle Archaic period artifacts (Price and Spiess 2007). Multibeam bathymetry, side scan sonar, seismic reflection profiling, and coring were used to identify a sheltered lake/wetland complex. It is possible that Paleoindian inhabitants used similar settings where available.

No archaeological material has been recovered from areas further offshore, however, draggers working to the south, offshore of Massachusetts, have recovered mammoth teeth (Whitmore et al. 1967). The presence of these proboscidean remains suggests that these broad, offshore areas were dominated by grassland/steppe environments, suitable to support large grazing animals and herd animals, such as mammoth and reindeer.

Potential Paleoindian occupation of these offshore areas would most likely be situated so as to best exploit available herd animals and coastal resources. Robinson et al.'s (2009) identification of the Bull Brook site as an aggregation site linked to hunting of migrating caribou requires the hunters to have knowledge of migration patterns and a potential familiarity with the landscapes available to prey species. Shaw et al. (2006) suggest a large subaerially exposed area with associated adjacent islands was present to the east of Cape Cod ca. 13,000–9,000 B.P., and may have provided hunting areas contiguous with the current mainland. Paleoindian hunters may have followed herd movements into this area, and even across limited expanses of open water. Use of boats by Paleoindian people is unsubstantiated, but has been suggested as a method of colonization of the coastal portions of western North America (Dixon 1999; Erlandson 2002; Erlandson et al. 2007; Fedje and Christensen 1999; Fladmark 1979). Paleoindian exploitation of coastal resources has not been recognized in northern New England and the Canadian Maritimes, primarily because any coastally focused occupation or resource-related areas of this time period are currently submerged. In other portions of the world, where coastal zones of Terminal Pleistocene age are preserved, Paleoindian sites are associated with marine mammal, fish, and shellfish remains (see Sandweiss et al. [1998] for an example from coastal Peru, the Quebrada Jaguay site).

Using available settlement models, Paleoindian period peoples are likely to have used subaerially exposed areas of the OCS, dependent upon access across areas contiguous with the coast or having the ability to navigate across open water. Sites may exist as: 1) small upland hunting and travel sites associated with surface water, such as springs, 2) multi-loci aggregation sites developed for group exploitation of resources, and 3) coastal sites positioned to access marine resources, including marine mammals, fish, and shellfish. Site preservation in these areas will be influenced largely by depth of burial and geological processes acting on the sites following occupation.

2.2.2. Early Archaic Period

The start of the Early Archaic period (ca. 10,000–7500 B.P.) coincides with the end of the Pleistocene and the Wisconsin glaciation and the commencement of the Holocene epoch 10,000 years ago. The early Holocene is marked by a climatic shift towards conditions that were generally warmer and drier than those of the preceding Pleistocene epoch. This shift produced concomitant changes in southern New England's environmental setting to which the region's Native American inhabitants at the time adapted. By the Early Archaic, the environment had transformed from open woodlands to more closed forests initially dominated by spruce, balsam fir, birch, and poplar, but eventually dominated by pine (Almquist-Jacobson et al. 2001; Bernabo and Webb 1977).

The Archaic period represented a time of increased familiarization and settlement within the Eastern Woodlands. Archaeological evidence recovered to date suggests native peoples of the Early Archaic followed a more diversified subsistence strategy relative to that of the preceding Paleoindian period. This more diversified subsistence strategy appears to have included the pursuit of available smaller game and fish as well as the gathering of available woodland and wetland vegetation, and nuts (Dumont 1981; Forrest 1999, Jones 1998; Kuehn 1998; Meltzer and Smith 1986; Nicholas 1987; Robinson et al. 1992). The archaeological record exhibits a strong correlation between Early Archaic habitation sites and wetland locations as many of the identified sites are located around the perimeters of ponds, marshes, and wooded wetlands and at the headwaters of major rivers. Consequently, from this distribution of sites, it may be inferred that wetland environments became increasingly important loci for human activity during the Early Archaic (Jones and Forrest 2003; Nicholas 1987).

Identification of Early Archaic habitation sites throughout southern New England has typically hinged upon the recovery of corner-notched, stemmed, and bifurcate-based projectile points during archaeological surveys. Recent documentation of Early Archaic sites in New England has led researchers to question whether Early Archaic archaeological deposits are in fact rare as initially believed (i.e., Sanger 1977), or have simply been overlooked because they may be difficult to discern from later archaeological components given the widespread presence of quartz throughout much of New England during the pre-contact past. Excavations at very deeply buried sites along major rivers in Maine have yielded important evidence of Early Archaic occupations. Investigations along the Saco, Kennebec, Androscoggin and Penobscot rivers have prompted the identification of what has been called, —The Gulf of Maine Archaic Technological tradition” (e.g., Robinson 1992; Sanger 1996; Will et al. 1996).

Non-bifacial tools that include unifacially edged tools, cores, and flakes have been proposed as alternative diagnostic markers for the period (Robinson et al. 1992), as have —ribbed flakes” or —denticulates” and tabular blades (Thomas 2001; Waller et al. 2010). This assemblage, subsumed within the Gulf of Maine Archaic tradition, also includes hammerstones, milling slabs, and notched pebble sinkers (Waller et al. 2010). Artifact types crafted using this new technology of pecking and grinding reflect an increased focus on plant and fish resources during the Early Archaic (Robinson 1992). Chipped stone tools were typically produced from local stone, often collected in cobble form, suggesting more restricted territorial ranges than in Paleoindian times. Archaeological investigations of the Sandy Hill Site in Ledyard, Connecticut (Forrest 1999), record the early Holocene utilization of a distinctive quartz lithic technology focused on the

production of quartz “microliths” for use in composite tools (Forrest 1999). The preponderance of expedient tools and nearly exclusive reliance on local or regional lithic materials are characteristic of this tool assemblage, and suggest either a “restricted wandering” or a “central-based wandering” settlement system (Waller et al. 2010). A restricted wandering settlement system consists of seasonally based group movements by small, residential groups within well-defined territorial limits, while a central-based wandering settlement system describes settlement at a place for an extended period of time by a modest population until the time arrives when the entire community finds it necessary to move on, perhaps never to return (Ritchie 1980).

The identification of a semi-subterranean pit house associated with a LeCroy Bifurcate complex at the Weilnau site in Ohio (Stothers 1996), a pit house dated to 8920 ± 100 B.P. from Connecticut (Forrest 1999), and more recently two pit houses dated to 7830 ± 130 and 8110 ± 90 B.P. at the Whortleberry site in Dracut, Massachusetts (Dudek 2005), imply a previously unknown degree of sedentism for Early Archaic populations (Waller et al. 2010). It is inferred that these larger, longer-duration residential sites were associated with peripheral small, short-duration sites resulting from logistical forays in the Early Archaic settlement system. Jones and Forrest (2003) assert that the Early Archaic semi-residential settlement pattern in southeastern Connecticut is an adaptive response to predictable, readily abundant resources (Waller et al. 2010).

2.2.3. Middle Archaic Period

The environmental setting associated with the Middle Archaic (ca. 7500–5000 B.P.) is characterized by increased precipitation relative to the preceding Early Archaic period. Forest composition and vegetation changed in response to the increased rainfall as the pine-dominated landscape was replaced by a deciduous forest of oak, sugar maple, elm, ash, and beech, with smaller numbers of hemlock and white pine. Deer populations expanded and likely became a major subsistence focus with the emergence of the “mast” forest. Bear, wolf, otter, and wild turkey also emerged in greater numbers, while comparatively smaller populations of moose, elk, and caribou populations persisted in spruce-fir northern hardwood forests.

An increase in the relative frequency of Middle Archaic sites in the Northeast suggests that colonizing peoples were firmly established in New England by 7500 B.P., with a greater density of identified Middle Archaic sites occurring in southern New England than in the north (Waller et al. 2010). Southern New England’s resident Middle Archaic populations continued their generalized subsistence regimes with most sites of the period discovered around ponds, lakes, rivers, and wetlands (Bunker 1992; Dincauze 1976; Doucette 2005; Doucette and Cross 1997; Maymon and Bolian 1992). Subsistence activities reflected at these sites included the focused harvesting of anadromous fish, hunting and foraging, and fishing. Base camps established along extensive wetland systems (Doucette 2005; Doucette and Cross 1997; Jones 1998) supplemented smaller logistical camps and exploitation sites within the Middle Archaic settlement system. An increase in the complexity of seasonal rounds is conjectured on the broad range of resources available throughout the period (McBride 1984).

Middle Archaic occupations in southern New England are typically identified by the presence of Neville, Neville-variant, Stark, and Merrimack style projectile points (Dincauze 1976; Dincauze and Mulholland 1977). The Neville type-site for Middle Archaic Native

American occupations in New England was situated along the Merrimack River in Manchester, New Hampshire, and contained a substantial Neville projectile point tool assemblage. Many of these points possessed slightly bifurcated or notched bases, thus providing evidence for a possible technological evolution out of the preceding bifurcate-based Early Archaic point type. The site was used repeatedly beginning roughly 7750 B.P., probably as a seasonal base camp situated to take advantage of migratory fish runs. Besides fishing, other activities represented by artifacts and features at the site include stone tool manufacture, hide working, and wood working (Dincauze 1976). At Middle Archaic sites throughout New England, projectile points are found in association with steep-bitted scrapers, flake knives, perforators, adzes, axes, gouges, and choppers. Groundstone tools became more central to the material culture of the Middle Archaic. The presence of adzes, gouges, and axes within the archaeological record suggests heavy woodworking activities and the possible manufacture and use of dugout canoes, which is further suggestive of the increased importance of river travel for Middle Archaic peoples (Waller et al. 2010).

A preference for regionally available lithic raw materials (quartzite and rhyolite) is reflected in the Middle Archaic's archaeological record. Utilization of Ossipee Mountain and Boston Basin volcanic materials is also evident during the Middle Archaic, although quartz apparently remained the raw material of choice (Bunker 1992). The correlation between regional lithic material types and Middle Archaic materials has led Dincauze (1976) to theorize that Native American band or tribal territories were established within major river drainages, and that the scheduling of subsistence activities such as the seasonal pursuit of anadromous fish species may have developed in response to territoriality (Dincauze and Mulholland 1977; Waller et al. 2010).

In Maine, chipped stone spear points are more abundant in the Middle Archaic archaeological record and the first cemetery sites occur. Artifacts dating to this time period have also been discovered submerged in places, such as Blue Hill Bay suggesting that sea level rise has submerged sites from this time and earlier (Crock et al. 1993). The cemetery sites reveal mortuary practices that included the sprinkling of graves with red ocher, and the offering of grave goods, such as gouges, slate spear points, and stone rods (Moorehead 1922; Robinson 1992; Will and Cole-Will 1996; Willoughby 1898). Commonly referred to as the "RedPaint People," sites dating to this tradition have typically been found east of the Kennebec River with some sites displaying a strong focus on maritime resources.

2.3. MID COAST

Surveys of regional prehistory associated with the modern states of New York, New Jersey, Delaware, Maryland, and Virginia are provided by Cross (1941), Custer (1984, 1989), Dent (1995), Kraft (1986), Mounier (2003), and Ritchie (1980). Archaeologists working in this region have traditionally employed a system of three periods (Paleoindian, Archaic, and Woodland) to divide the span of time between the first settlement of the region by Native Americans and the arrival of the European explorers in the sixteenth century. The Paleoindian period spans roughly 12,500–10,000 B.P. It is followed by the Archaic, divided into four periods: Early Archaic (10,000–8000 B.P.), the Middle Archaic (8000–6000 B.P.), the Late Archaic (6000–3000 B.P.), and the Transitional or Terminal Archaic (3000–2700 B.P.). The Woodland period postdates any possibility for submerged sites on the OCS.

At the Pleistocene glacial maximum, the Laurentide ice sheet extended as far south as present-day New York City. After the retreat of the glacial ice sheet, tundra vegetation, similar to that found today in Alaska and northern Canada, colonized the newly exposed landscape (Gaudreau 1988). Between 19,000–11,000 B.P., a spruce-dominated forest was present, retreating northward and eventually replaced by a forest dominated by pine. Finally, by 9000 B.P. (during the Early Archaic period) hardwood forests, similar to those that characterize the Eastern Woodlands today, were present throughout the region.

2.3.1. Paleoindian Period

Only a few sites dating to the Paleoindian period are known from this portion of the Atlantic coast, while the presence of early peoples is implied from the occasional find (often on the surface) of characteristic fluted projectile points that were presumably used to hunt Late Pleistocene/Early Holocene fauna (Anderson and Faught 1998). The relative scarcity of early sites along the modern coast is to be expected. Even if the region was well-populated prior to 10,000 B.P., most of the evidence for early human presence has been destroyed or hidden by natural or cultural processes. Foremost among these forces is the post-glacial rise in sea level. During the initial settlement of the region, sea level was roughly 100 m lower than today, meaning that, for example, what is now lower New York Harbor would have been exposed land, cut by stream channels of the Hudson and Raritan rivers.

The first reported Paleoindian habitation site in eastern North America was at Shoop, Pennsylvania (Witthoft 1952). This discovery was soon followed by the Reagan site in Vermont (Ritchie 1953) and the Bull Brook site in eastern Massachusetts (Byers 1954). Another early site, Meadowcroft Rockshelter, probably has received more attention than any other early prehistoric site excavated in eastern North America, due in large part to the very early radiocarbon dates obtained for the lowest artifact-bearing strata. The site is located in southwestern Pennsylvania, approximately 50 km south of the maximum extent of the last advance of the Wisconsin ice sheet, and overlooks a small tributary of the Ohio River. The rockshelter deposits are deep, stratified, and contain several cultural components, with an internally-consistent suite of radiocarbon dates ranging from at least between 685±80 through 13,240±1010 B.P. (Adovasio et al. 1990). No fluted projectile points were found in the lowest strata at the Meadowcroft Rockshelter, leading the principal investigator to suggest that the deposits were created by people earlier than, or at least outside of, the fluted point Paleoindian tradition (Adovasio 1993).

Another well-studied stratified Paleoindian site is the Shawnee Minisink site in the Upper Delaware River Valley of eastern Pennsylvania. Charcoal from hearths in the Paleoindian component of the Shawnee Minisink site has been radiocarbon dated to 10,590±300 and 10,750±600 B.P. (McNett 1985:6). More than 76 seeds from at least 10 different plant species were recovered from Paleoindian contexts at the site (Dent and Kauffman 1985:67). Interestingly, there are only minor differences between the Paleoindian and Early Archaic botanical assemblages from the site. In addition to the wide variety of seeds and fruits at Shawnee Minisink, fish bones were encountered in Paleoindian contexts (Dent and Kauffman 1985:73).

In general, Paleoindian settlement patterns may be described as semi-nomadic within a defined territory. The subsistence focus was on hunting both large and small game and it is

assumed that wild plants were exploited for their food potential as well (Custer et al. 1983; Gardner 1980; Kraft 1973). Populations of Pleistocene megafauna, such as mammoth and mastodon, were likely dwindling by this time, but pre-Clovis populations, if they existed, may have utilized a much richer late Pleistocene ecosystem marked by extensive estuarine systems, high order stream terraces, broad open grasslands, and wetland habitats. Sites such as Cactus Hill (44SX202), on the Nottoway River in Virginia, show evidence of coastal plain riverine settings being heavily utilized in Clovis and what appears to be pre-Clovis times (McAvoy and McAvoy 1997). Cactus Hill may have been one of a series of smaller sites located upstream from the Atlantic shelf for the purpose of raw material replenishment as well as hunting and gathering. Similar riverine settings further inland were exploited as well. The Higgins site (18AN489), for instance, is a Clovis site on the western shore of the Chesapeake near Baltimore-Washington International Airport in a small stream setting in a headwaters area (Curry and Ebright 1990; Ebright 1989, 1992).

Many regional Paleoindian sites are located adjacent to what would have been fresh water sources at the time of occupation. During the Late Pleistocene, lowered sea levels and associated lowered ground water tables resulted in fewer fresh water resources compared to Holocene conditions, and the few resources that were present undoubtedly attracted human foragers. Fresh water locales would have been visited repeatedly by Paleoindians, and thus these sites are more visible in the archaeological record than environmental niches used only sporadically. Mounier (2003:126), for example, notes that almost all habitation sites from all prehistoric periods in New Jersey are located near fresh water. Two Paleoindian sites, two sites with redeposited Paleoindian period artifacts, and 12 isolated finds (mostly fluted projectile points) have been documented on the outer coastal plain of central and southern New Jersey (Grossman-Bailey 2001:171–184). An additional 12 fluted points, most made from jasper, with others from quartzite and argillite, have been recovered on the coastal plain between Sandy Hook and Barnegat Bay in central New Jersey (Marshall 1982). Numerous Paleoindian isolated finds have been identified in the Chesapeake Bay area, but relatively few intact sites are documented. Brown's (1979) survey of fluted points in Caroline County, Maryland shows five points—four Clovis and one mid-Paleo. The dearth of sites is attributed, in part, to the notion that many regional Paleoindian site locations are submerged. An upland site, Paw Paw Cove in Maryland (Dent 1995; Lowery 1989), is located close to ancestral Susquehanna River terraces overlooking where the Choptank and Miles rivers flow into the Susquehanna. Locations such as this may simply have been utilized for its proximity to rich floodplain areas resources. Some evidence also suggests that site location choices were designed to provide protection from the elements. One common pattern consists of southern exposure sites adjacent to topographic features that provide shelter from prevailing winds (Dent 1995:124).

Paleoindian technology is distinguished by the distinctive fluted projectile points and specialized tool kit that included scrapers, burins, graters, denticulates, spokeshaves, perforators, knives, *pièces esquillées*, and unifacial flake tools. Tools include highly specialized formal implements, multi-purpose tools, and expedient tools. A variety of high quality cryptocrystalline raw materials were utilized such as chert, jasper, and quartz. Kraft (1986) notes that fluted points diminished in size after Clovis, ultimately being replaced by notched Early Archaic points such as Palmer and Kirk.

The geography of Paleoindian settlement patterns has traditionally been interpreted based on a presumed reliance on high-quality lithic raw material, and thus an attraction to source areas (Gardner 1989). The use of cryptocrystalline raw material facilitates hunting and gathering expeditions outside the usual lithic resource procurement area by allowing portable, flexible technologies based on bifaces and blade cores with long life spans that can be reliably used, resharpened, and recycled as Paleoindian groups moved across the landscape (Goodyear 1979). Artifacts associated with this period in the region include high percentages of cryptocrystalline material, although the picture of Paleoindian resource use is becoming more nuanced. Many coastal plain sites (e.g., Paw Paw Cove) show intensive use of high quality cobble resources such as jasper instead of more distant outcrop sources (Custer and Galasso 1980; Custer and Lowery 1994; Lowery 1989). Where high quality cryptocrystalline raw material was not available locally as outcrops or cobble sources, one might expect a high percentage of curated tools (manifested by resharpening) and blanks transported from source areas elsewhere. That indeed is what is seen at the Shoop site, north of Harrisburg, Pennsylvania, where many fluted points, scrapers, and other typical Paleoindian tool forms were made from Onondaga chert, a raw material found in western New York north of the Finger Lakes region (Carr and Adovasio 2002; Witthoft 1952, 1954). Some Paleoindian groups in the region did, however, make use of lower quality local lithic raw materials as well. For example, in the Chesapeake drainage and in other portions of the coastal plain, Paleoindian assemblages include a high percentage of local, non-cryptocrystalline material such as quartz and quartzite (Dent 1995:127). Cryptocrystalline raw materials of high quality were more likely to be used for tools that would be curated and reused, while locally available resources would have served well for expedient tools (Goodyear et al. 1989).

Lithic resources, like fresh water sources, may have served as focal points of human occupation on the landscape. Stratified sites containing Paleoindian artifacts in an area rich with good lithic raw material include the Thunderbird and Fifty sites of the Flint Run Complex in the Shenandoah Valley of Virginia (Gardner 1977). The —Flint Run Lithic Deterministic” model of Paleoindian settlement, where the movements of small groups of Native Americans across the landscape were made to take advantage of this important lithic source (Anderson and Sassaman 1996), was based on finds at the complex, which included quarries, reduction sites, base camps, and maintenance camps. On the Delmarva Peninsula, there appear to be two mechanisms responsible for the distribution of fluted projectile points. One concentration in the north centered on the Delaware Chalcedony Complex may reflect the Flint Run model, where Paleoindian artifacts are associated with outcrops of high quality lithic raw material. Two other concentrations of fluted points are along the mid-peninsular drainage divide, where the Late Pleistocene-Early Holocene environment was riddled with swamps and wetlands attractive to game (Custer et al. 1983), and at the mouths of the Choptank and Nanticoke rivers (Custer 1989:94, 103). Custer (1989) believes that Paleoindian sites clustered along the upper reaches of the mid-peninsula drainage divide are base camps; however, Lowery and Phillips (1994:33) believe that they are temporary camps.

Known site types for the Paleoindian period in the region include riverine base camps located near high-quality lithic sources and smaller transient hunting camps near game-attractive areas. For example, Werner (1964:31) describes a jasper Clovis point, hearths and associated debitage from an alluvial terrace context at the Zierdt site in the Upper Delaware valley. Kraft (1973) describes similar riverine contexts at Plenge in the Muscongecong River valley of western New Jersey. Larger sites, such as Shawnee-Minisink (McNett 1985) may have been occupied for a

longer period of time or as some suggest, may represent a series of brief occupations over the long term to exploit nearby chert outcrops (Gingerich 2007). Most of the recorded Paleoindian sites along the Middle Atlantic coastal plain, however, are either short-term camps or isolated finds. Isolated finds include several locations along the Delaware River described by Kinsey (1972:328; see also Marshall 1982). Many of these projectile points are surface finds on kame terraces on both the Pennsylvania and New Jersey sides of the Delaware River. It is likely that Paleoindian sites in downstream areas of the Delaware, Susquehanna and Potomac, for example, would have included larger camps, now inundated, occupied for exploiting rich estuarine resources and the smaller, backwater swamps. From these camps, forays into upstream and interior headwater areas (e.g., Turkey Swamp) would have been staged. Such activity would account for the broad distribution of isolated fluted points and small sites that typify coastal plain site settings today.

The fundamental problem with investigating Paleoindian coastal adaptations is that the evidence is presumably underwater. However, a few sites on the West Coast (where the continental shelf is relatively narrow, and sea level rise had much less effect than in the East) have yielded ample evidence of early maritime adaptations. For example, a deep shell midden of marine shellfish remains, fish bones, and lithic artifacts at the Daisy Cave site on San Miguel Island, California, has been dated to 9,700 B.P. (Erlandson 1993, 1994). Nevertheless, it is unclear what role aquatic resources, particularly fish and marine mammals such as seal, may have in Paleoindian subsistence in the region. Fish bones were recovered from the Shawnee Minisink site in the Delaware River Valley (McNett 1985), and preservation factors may explain their absence elsewhere. The degree of hunter-gatherer dependence on maritime resources during the Late Pleistocene and Early Holocene has been a matter of debate (Yesner 1980). Some researchers (e.g., Perlman 1980) have postulated that because coastal environments are among the most productive land forms (in terms of food and raw material diversity and abundance), their occupation should coincide with their earliest development and stabilization. In contrast, others (e.g., Bailey and Parkington 1988; Erlandson and Fitzpatrick 2006) see a trend of expanding subsistence patterns to include specialized niches such as the coast over the course of the Holocene. The use of marine resources as an alternative subsistence strategy in times of seasonal nutritional stress is documented in the ethnographic literature and may serve as a model for possible Paleoindian subsistence practices. For example, historically-known Northeastern hunter-gatherer groups such as the Beothuk in Newfoundland relied heavily upon a variety of aquatic resources (especially seal, salmon, cod, smelt, herring, sturgeon, and shellfish) at least part of the year (Reynolds 1978). Furthermore, the ethnographic record of North American hunter-gatherers suggests that coastal groups relied heavily on fish and other aquatic resources, regardless of latitude or effective temperature (summarized in Kelly 1995:Table 3-1). Work on submerged early prehistoric sites in eastern North America could potentially yield data to address this problem.

In the southern portion of region, bathymetric research by Blanton (1996) indicates that the Pleistocene lands now submerged in the Chesapeake Bay along the East Coast are also likely to contain Paleoindian sites. Tidal forces on such submerged sites may explain why, within the Lower Delmarva region, the coastline along Tangier Sound is one of the two main areas from which Paleoindian points have been reported, the other being the interior drainage of the middle Pocomoke River (Davidson 1981:11).

2.3.2. Archaic Period

The Archaic period is characterized by the gradual development of more-or-less modern environmental conditions. Humans adapted to the abundant resources provided by interior woodlands, ponds, and rivers, as well as coastal estuaries by exploiting a broad range of food (nuts, large and small game, seed-bearing plants, fish, etc.) and industrial products (stone for making tools and weapons, plants for baskets and textiles, bark for house construction, etc.). By 6000 B.P. the region was heavily settled, with populations on the coast and offshore islands likely numbering in the thousands. Archaeological evidence of this apparent population “explosion” is reflected in the large number of terrestrial archaeological sites dating to the Late Archaic period, and by the large size of some individual settlements (Mounier 2003; Ritchie 1980). However, the Late Archaic period is roughly coincident with slowing sea level rise rates and the establishment of the modern coastline. Late Archaic period lifeways in the Mid-Atlantic region have a significant coastal component, characterized by the presence of shell middens, especially towards the latter part of the period when sea levels were closest to current positions (Braun 1974). The model of lower population during the Early and Middle Archaic periods, followed by population growth during the Late Archaic, is based upon the terrestrial archaeological record, and may not adequately consider the fact that numerous earlier sites presumably are now submerged on the formerly subaerial portions of the continental shelf.

To illustrate this point, Lowery (2009) plotted Late Woodland-age sites within the Choptank River watershed. Included in this analysis were numerous coastal Late Woodland sites that included large shellfish refuse middens. To understand the impact that marine transgression has on the interpretation of the archaeological record, he induced a hypothetical 20-m sea level rise event. As a result, all of the coastal Late Woodland midden sites in the Choptank watershed would be drowned and the surviving interior upland sites would not provide any clues that prehistoric human societies were interested in coastal or estuarine resources. Since the early prehistoric archaeological record has been impacted greatly by marine transgression, previous interpretations about this record are probably inaccurate. Some syntheses have suggested that early prehistoric societies in the Middle Atlantic may have been only marginally interested in coastal resources with their subsistence patterns primarily focused around interior upland resources (Custer 1988). Thus, the early prehistoric archaeological record is biased by the fact that these upland settings are the only landscapes that have survived marine transgression.

Regardless of the likelihood that people were living on the now-submerged coast, major shifts in social organization and mobility strategies are not suggested by the archaeological record at several regional sites, including Meadowcroft and Shawnee Minisink, which contain substantial Early Archaic components underlain by Paleoindian material. At Shawnee Minisink in particular, the archaeological record is indicative of continuity in human adaptations, with gradual intensification of local resource use and broadening of diet breadth over time (McNett 1985). No decline in Early Holocene population size is indicated by a recent inventory of prehistoric sites on the outer coastal plain of New Jersey (Grossman-Bailey 2001), where 16 Paleoindian, 19 Early Archaic, 43 Middle Archaic, and 199 Late Archaic components were identified. Archaic toolkits expand in diversity, including the introduction of more plant-processing tools (e.g., mortars and pestles) on the Delmarva Peninsula, but the types of locations chosen for occupation were essentially the same between the Paleoindian and Archaic periods (Custer 1986). Similarly, in the Chesapeake region, there does not appear to be a marked division

between the Paleoindian and Early Archaic periods. Instead, settlement and subsistence patterns may reflect settling into an expanding mixed hardwood forest made possible by emerging modern environmental conditions. The Early Archaic in the southern part of the region is characterized by an increase in the number and diversity of archaeological sites (Anderson and Sassaman 1996; Custer 1990).

Just as the fluted projectile point is regarded as representative of Paleoindian activity, a variety of side-notched, corner-notched, and points with bifurcated bases represent the Archaic period in the region. Stratigraphic data used as a basis for a local sequence of projectile point styles has been derived from a variety of stratified and single component sites in the Middle Atlantic and surrounding region (e.g., Broyles 1971; Coe 1964; Gardner 1974; Kinsey 1972; McNett 1985; Michels and Smith 1967). Diagnostic artifacts representing Early Archaic occupations in the region include primarily Palmer corner-notched, Kirk corner-notched and stemmed, MacCorkle, Kanawha, Thebes, Charleston, and a variety of lesser known types. Some researchers (e.g., Carr 1998; Custer 1996; Gardner 1987, 1989) consider the early side- and corner-notched projectile point types, such as Palmer, Amos, and Kirk, as diagnostic of late Paleoindian period occupations, suggesting continuity in both technology, including very selective raw material choice, and settlement patterns.

Several sites on Staten Island have yielded Early Archaic bifurcated points, including the large multi-component site at Ward's Point, which yielded 21 bifurcated base points, 16 other projectile points, and other stone tools. Charcoal from a hearth feature was radiocarbon dated to 8300±140 B.P. (Ritchie and Funk 1971). The West Creek site, on the mainland behind Little Egg Harbor in southern Ocean County, New Jersey, had three loci of prehistoric activity likely dating to the Early Archaic period. Jasper and chert tools included Kirk and Palmer projectile points and scrapers. Features of calcined bone at the West Creek site, radiocarbon dated to approximately 9850 B.P., probably represent human cremation burials (Mounier 2003:198). Elsewhere in the region, a suite of radiocarbon dates clustered around 7950 B.P. from a hearth feature at the Turkey Swamp site on the outer coastal plain in northeastern New Jersey (near Freehold, Monmouth County) places it within the Early Archaic period, despite the presence of several basally-thinned triangular projectile points that are "reminiscent" of Paleoindian forms (Cavallo 1981). Early Archaic bifurcate base projectile points are found thinly scattered across the region, perhaps representative of hunting losses or small camp sites.

Early Archaic settlements tend to be located on well-drained surfaces adjacent to rivers, ponds, and wetland terrain. For example, the Chance site (18SO5) is an Early Archaic site on the lower Delmarva Peninsula that has produced hundreds of serrated notched and bifurcate projectile points, all from the surface in a large swamp setting (Cresthull 1971, 1972; Dent 1995:171). When the site was occupied, this location may have been the headwaters of a series of drainages overlooking the ancestral Susquehanna River (Custer 1989:107).

Hughes' (1980:117) comprehensive study of artifact collections from Maryland's lower eastern shore indicates that Early Archaic sites in the region are commonly situated on well-drained ridges adjacent to freshwater streams and wetlands. Lowery (1995:23) found that in the low coastal plain resource zone, Early Archaic sites are also found adjacent to springheads. One Early Archaic site (18DO382) is located on a hilltop on Opossum Island, just east of Barren

Island. Lowery (2001, 2003) has continued to focus on these drowned shoreline areas further south in Accomack and Northampton counties, Virginia.

The Middle Archaic is the least well-represented period in the region. During this period (roughly 8000–6000 B.P.), continued climatic warming and increased precipitation led to a near-modern landscape. Technologically, the transition from the Early Archaic to the Middle Archaic is characterized by the appearance of bifurcate based and stemmed rather than notched projectile points (Custer 1989). Stanly (ca. 8000–7500 B.P.), Morrow Mountain I and II (ca. 7500–5500 B.P.), Guilford (ca. 5500–5000 B.P.), and Halifax/Vernon (ca. 5000–4000 B.P.) projectile points mark the Middle Archaic period in the general region, following the classic Archaic sequence first identified by Coe (1964). Most Middle Archaic sites are known through projectile point finds on Holocene terraces and upland surfaces as well as along estuaries, swamp margins, and near springheads. Interior streams fringed by wetlands were also common site locations, as can be seen in the case of 18DO220 and 18DO139, located respectively at the mouth of Slaughter Creek and on a bank of the Chicamacomico River on Maryland's eastern shore (Lowery 1995:23, 2001, 2003).

As with earlier Holocene sites, numerous Middle Archaic manifestations are probably located in drowned valleys and estuaries on the outer coastal plain. Lowery and Martin (2009) recorded an inundated Middle Archaic burial site in the Chester River, Maryland, which implies there may be large numbers of sites along much of the submerged terrain near the present shorelines of Chesapeake Bay as well as Atlantic shelf areas of the Middle Atlantic region. The Middle Archaic sites may not be as far from shore, as evidenced by Lowery's Chester River find, indicating rising sea levels may have already inundated much of the broad, open Late Pleistocene coastal plain.

Middle Archaic occupations represent significant changes in Early Holocene adaptations in the region that involve exploitation of a wider range of environments and new additions to tool kits such as drills and, later, groundstone items. The use of netsinkers indicates the more intensive use of riverine environments for fishing (Kraft 1986). Subsistence economies became increasingly diversified as new resources were being exploited seasonally (Custer 1989).

The earliest well-dated evidence for shellfish utilization in the region is the Middle Archaic midden at Dogan Point, adjacent to the lower Hudson River (Claassen 1995). The site's radiocarbon date of 5650 ± 200 B.P. makes it the one of the oldest shell middens on the Atlantic coast of the United States. One of the site's excavators noted that the early shell-bearing levels at Dogan Point suggest "that the use of marine resources occurred prior to the stabilization of sea level ca. 5000 years ago and that inundation of earlier coastal sites, not cultural retardation, accounted for the lack of shell matrix sites before sea level stabilization" (Claassen 1995:3).

The trend toward an increased reliance on local lithic sources noticed during the Early Archaic continued into the Middle Archaic. Raw materials commonly utilized during this time include chert, argillite, jasper, quartz and rhyolite. Evidence from the Higgins site suggests that a rhyolite trade system was becoming established with the import of rhyolite blanks from the north (Ebright 1992).

During the Late Archaic period (ca. 6000–3000 B.P.), regional populations appear to have grown markedly and, with the culture associated with broad blade technology in particular, to have concentrated in larger base camps in riverine and estuarine settings. The proliferation of archaeological sites dating to the Late Archaic may overplay population growth from earlier periods when proportionately more sites are now submerged. By 5000 B.P. sea level appears to have been relatively stable, with only minor fluctuations, but between 0.5–2 m below present-day level (Blanton 1996; Carbone 1976; Tanner 1993).

The main projectile point types believed to be diagnostic of the Late Archaic period in the northern part of the region consist of stemmed types, such as Bare Island, Lackawaxen, Lamoka, Poplar Island, and Rossville (Ritchie 1971). In the Chesapeake Bay area, diagnostic projectile point types for the Late Archaic include a narrow blade series, with Vernon, Claggett, and Piscataway types. Orient Fishtail and Dry Brook projectile types as well as the broad blade types including Savannah River, Susquehanna, and Perkiomen and steatite pottery are commonly associated with the later portion of the Late Archaic. In northern Virginia near the end of the Late Archaic period, there appears a set of broad-bladed lithic tools, called the Susquehanna Complex, frequently made from rhyolite similar to that found in Maryland and Pennsylvania (McLearn 1991). A combination of narrow-bladed stemmed points (e.g., Bare Island, Lackawaxen) and broadspears, together with steatite (soapstone) vessels, characterizes the Late Archaic Clyde Farm-Barkers Landing Complex on the Delmarva Peninsula (Custer 1989).

Carved soapstone bowls are fairly common in Late Archaic assemblages, as are ground and chipped axes, choppers, net-sinkers, and pestles. The proliferation of grinding implements and cooking vessels may suggest increased use of plant resources and possibly changes in subsistence strategies and cooking technologies. Net-sinkers could suggest greater commitment to fishing in the subsistence economy. Alternatively, all of these more specialized implements may indicate a more sedentary existence where people were willing to invest in the creation of a more elaborate toolkit that would not have to be transported from place to place. Although evidence is minimal, the first experiments with horticulture probably occurred at this time, with the cultivation of plants such as squash, sunflower, and chenopodium (Cowan 1985; Ford 1981). Evidence from the Higgins site and other Late Archaic sites in the region show that among the exploited resources were deer, turkey, beaver, raccoon, opossum, berries, wild legumes, fish, oyster, and clam (Ebright 1992).

Settlements appear to have shifted from swampy upper reaches of inland streams to the mouths of major streams and rivers, perhaps in response to the establishment of more stable estuarine environments relatively close to present-day shorelines (Davidson 1981:14). On the other hand, comparable settings in earlier periods would now be submerged in most cases. Lowery (1995:23) notes that Late Archaic settlement patterns in riverine settings (e.g., the Little Choptank River) show a preference for points of land. Sites are typically found on points of well-drained lands surrounded by broad tidal rivers, creeks, or estuaries. This type of landform is common in the Chesapeake Bay region (as evidenced by the numerous regional locational names that include the word “—point” (e.g., Hooper Point, Poverty Point, and Holland Point), as well as along other major drainages such as the Delaware and Potomac. During the Early-Middle Holocene these “—points” were low terraces adjacent to streams and fringed by wetlands or broad tidal marshes, and sites at these locations were primarily established for marine resource exploitation, probably anadromous fish.

Late Archaic sites seem to have been occupied longer than in earlier periods; as the climate became more temperate and sea level more stable, resources became more predictably established across the landscape. The existence of formal residential base camps occupied seasonally or longer is inferred for riverine and estuarine locations, together with a range of smaller, resource exploitation sites such as hunting, fishing, or plant-collecting stations (Gardner 1987). The smaller sites are scattered broadly over the landscape on every habitable surface that is well-drained and is associated with nearby surface water. In addition to the numerous upland and riverine terrestrial sites dating to the Late Archaic, there are likely additional long-term camps, perhaps in great numbers, just offshore where rising sea levels have inundated sites over the last few thousand years.

By the end of the Archaic period, sea levels had risen to such an extent that later Woodland period sites are generally not expected on the continental shelf, although sites of all ages that are located on the modern coastline are currently witnessing submergence as sea levels continue to rise. Human activities of the relatively recent past, notably damming streams to form mill ponds and reservoirs, have also resulted in the creation of underwater archaeological sites.

2.4 SOUTHEAST

2.4.1. Paleoindian Period

The Paleoindian occupation of the Southeast is known predominantly from deflated surface sites (e.g., Anderson 1990a:173; Anderson et al. 1990:44–45; McCary 1947, 1948; Perkinson 1971, 1973), and due to a general lack of radiometric dates the timing of the initial colonization of the region is inferred from dates in the Northeast (Levine 1990) and Southwest (Haynes 1992). The most readily identifiable and accepted diagnostic Paleoindian projectile point is the classic Clovis, which occurs ubiquitously throughout North America. Unidirectional cores used to manufacture prismatic blades, as well as artifacts related to blade core maintenance and the blades themselves have been increasingly seen as potentially diagnostic of the early Paleoindian period due to their association with Clovis points in the Southwest (Collins 1999) and the Southeast (Broster and Norton 1993; Sain 2008). Formally hafted end scrapers also constitute an identifiable part of the Paleoindian toolkit, and these appear related to the working of hides (Daniel 1998).

Formal variation in projectile point morphology began to emerge in regions of the Southeast by about 11,000 B.P., probably due to restricted movement and the formation of loosely defined social networks and habitual use areas (Anderson 1995; Anderson et al. 1992). These later forms include the Dalton, Cumberland, San Patrice, Suwannee, Simpson, Beaver Lake, and Quad types, to name some (Anderson 1990a:67–69; Anderson et al. 1990; Coe 1964; Daniel 1997; Justice 1987:17–43; Milanich and Fairbanks 1980). Morse et al. (1996:327) point out that the designation of multiple subdivisions of the Paleoindian period is somewhat arbitrary at present, and at least in the Mississippi River valley there is evidence that Dalton points may overlap Clovis temporally. These are, however, regarded generally as a terminal or transitional Paleoindian sub-period point type (Culpepper et al. 2000).

Paleoindian tools are often manufactured of high-quality lithic materials that are recovered archaeologically at a great distance from their source areas, suggesting a high degree of mobility

(or possibly trade) among populations. In accordance with this inference, the Paleoindian toolkit has been interpreted as an intensively curated technology, with cores that are ideally shaped to maximize both portability and efficiency with regard to use and potential tool manufacture (Goodyear 1979).

A significant wood, bone, and antler technology was used as well. Organic materials such as these do not preserve in the acidic soils that cover much of the Southeast, and they are very rarely found. At sites where they have been preserved, primarily at wet sites in Florida, it is clear that organic media such as wood, bone, and antler were very important. These materials were manufactured into projectile points, foreshafts, leisters, awls, and needles, to name just a few tool categories (Milanich and Fairbanks 1980).

Kelly and Todd (1988) have suggested that the low level of regional variation among Clovis points and associated toolkits indicates that populations exhibited a relatively generalized adaptation that would have been advantageous in colonizing new and unfamiliar terrain. They conclude that Paleoindian populations entering “unmapped” terrain would have benefited from a highly curated lithic technology since quarry locations would have been unknown, and hunting terrestrial fauna would have required less region-specific knowledge for processing than plant foods (Kelly and Todd 1988). While this is a cogent argument in consideration of colonizing populations, recent analyses have challenged the traditional view of Paleoindians as highly mobile with a subsistence strategy based on migratory (and now-extinct) large animals, such as mastodons (e.g., Mason 1962). This characterization may have overemphasized the role of hunting large animals due to better preservation of bones and artifacts associated with hunting (i.e. lithics), and an early interest in kill sites found in the southwestern United States (Kornfeld 2007). Archaeologists working in the Carolinas and Georgia have yet to document a clear association between Paleoindian tools and the remains of displaced and extinct animal species known to have been present as late as 11,000–10,200 B.P.—mastodon, bison, giant ground sloth, and giant armadillo, for example (Holman 1985:569–570). More recent archaeological evidence suggests a greater dependence on plant and large and small animal food resources in the Southeast (Hollenbach 2005, 2009; Meltzer and Smith 1986). There is very little evidence for resource exploitation in the littoral by Paleoindian peoples living in the Southeast. This fact is probably due to site obfuscation and destruction caused by coastal submergence during the Holocene, and not because the resources these ecozones contained were not used (e.g., Dunbar et al. 1988, 1992).

As modeled differences between Paleoindian and Archaic subsistence strategies become less pronounced, the distinction between these broad cultural periods relies on technological differences. Settlement models include small temporary camps and perhaps less frequent base camps occupied by loosely organized bands. Paleoindian groups relied on high-quality cryptocrystalline stone for tool manufacture, and many sites are associated with source areas for rhyolite, jasper, chert, and even quartz (see Daniel 1994; Gardner 1974; Goodyear 1979).

Known Paleoindian sites in the Southeast in general represented by Clovis and closely related variants are few in relation to other periods, and may be under-represented in the archaeological record (eroded from upland surface sites or eroded from or deeply buried in floodplains or offshore). Based on the relative numbers of fluted to later unfluted point styles, if

environmental conditions were a principal factor in determining tool design, then the use of Clovis points (and their particular suitable environment) may have been relatively brief.

Solid excavation evidence for Clovis-period sites in North Carolina, South Carolina, and Georgia is rare. The majority of Paleoindian sites in the region consist largely of diffuse lithic scatters at open locations, with more concentrated deposits in rockshelter or cave settings. No conclusive evidence of permanent structures or long-term encampments has been located for this time period in the Southeast, however, limited data have been recovered from intact contexts (Anderson and Schuldenrein 1985; Elliott and Doyon 1981; Gresham et al. 1985; O'Steen et al. 1986). Excavations at the Topper Site, on the South Carolina side of the Savannah River, exposed a Clovis level (Goodyear and Steffy 2003). While sufficient carbon samples to date the Clovis level were unavailable, optically stimulated luminescence (OSL) dating at the base of the level produced a date of $13,500 \pm 1000$ calendar years before present (Forman 2003). The site also offers tantalizing evidence of a pre-Clovis occupation. Here, in stratigraphic position below the Clovis levels, researchers uncovered a distinct lithic assemblage characterized by spatially clustered concentrations of multifaceted flakes and chunks of chert along with several flake tools (Goodyear 2005). These tools, referred to as "—bendbreak tools," are essentially thin flakes broken to provide a chisel-like working edge, some of which exhibit use wear patterns suggesting use as a burin or graver. This apparent pre-Clovis occupation is also distinguished by exploitation of a separate chert source than that of later occupations. Research at the Topper site is on-going and is subject to intense scrutiny.

Several models of early Paleoindian settlement patterning have been advanced in the past quarter century (see Anderson et al. [1992] for an overview). Some are concerned with Paleoindians in general (Anderson 1990b; Kelly and Todd 1988; Martin 1973), and others with regional trends (Anderson 1995; Gardner 1983; Morse and Morse 1983). Most are mechanistic models that portray specific economic strategies as primary reasons for how Paleoindians settled on and utilized the landscape. Each is slightly different in its focus, with primacy placed on one of three major influences: (1) the need to maintain access to prominent, high-quality raw material sources (e.g., Gardner 1983); (2) a preference for exploiting specific habitual use zones and staging areas (e.g., Anderson 1995); or (3) a nomadic or semi-nomadic existence dictated to a large degree by the movements and availability of large game (e.g., Kelly and Todd 1988).

2.4.2. Archaic Period

The Archaic period began around 10,000 B.P., and almost certainly was precipitated by Holocene climatic conditions. Warmer global temperatures generally defined warmer and wetter conditions in the Southeast. As a result of changing environmental conditions that led to shifts in botanical communities, Pleistocene megafauna had given way to deer and smaller mammals by the onset of the Holocene epoch. Because these changes are temporally coincident with emergent traditions in stone tool technology they are believed to have precipitated cultural changes among the populations.

Overall, this period is characterized by a reliance on game animals and wild plant resources, increasing use of local lithic materials, and subsistence settlement strategies contingent on specific environments. In much of the southeastern United States, the Archaic period is represented predominately by stone tools and debitage due to the acidity of southeastern soils in

open sites. Subsistence data of any kind is scanty, and is generally inferred based on evidence in other regions, especially from cave or rock shelter sites in the midcontinent. Such evidence points to use of a wide variety of nuts, seeds, fruits, and other plant foods, with documented plant domestication by the Late Archaic (e.g., Chapman and Watson 1993; Fritz 1990; Hollenbach 2009; Watson 1989). As early as the Middle Archaic, there appears to have been increased use of riverine and coastal resources, as shell middens appeared along many interior rivers and shell rings appeared along the coast (e.g., Claassen 1991, 1992; Marquardt and Watson 1983; Parmalee and Klippel 1974; Russo 2006). Notwithstanding the substantial shell midden base camps in the major interior river valleys and architecturally complex shell rings of the coast, Archaic sites tend to reflect small, short-term occupations. Group organization is presumed to have been highly mobile (as is expected for hunter-gatherers), as what were thought to be egalitarian groups made use of seasonally available resources in different environmental settings. However, some evidence exists for more permanent occupations, development of trade networks, and even inter-group or interpersonal violence (Daniel 1998; Gibson 2001; Sassaman 1991, 1993; Sassaman and Anderson 1996; Smith 1991). Even mound building had its origins in the Middle and Late Archaic in the Lower Mississippi Valley (Gibson 1994; Russo 1994; Saunders et al. 1994; Saunders et al. 1997; Saunders 1994).

The Archaic period is noted for populations with more regionally distinct tool kits (compared with those of the preceding Paleoindian period), with greater diversity in projectile point forms and site sizes. Although there are broad similarities in artifact styles throughout the Southeast, there is also sub-regional variation in biface attributes and sequences. There are no clear boundaries between Archaic cultural periods, although each can be characterized in ways that differ from other Archaic subperiods. It is likely that there was a great deal of cultural as well as technological continuity between the subperiods.

The Early Archaic period is marked by the end of the glacial climate and extinction of numerous large animals. Regional population densities on the Atlantic Slope were concentrated along major river systems, especially the Pee Dee, but also the Savannah, Neuse, and Roanoke rivers (Sassaman and Anderson 1994:171–175); the greatest concentrations were generally at or near the Fall Line, rather than the coastal plain. Again in this period, low regional population densities with a high degree of group mobility are inferred (Claggett and Cable 1982). There are several distinct characteristics that have been noted for Archaic period sites throughout the Southeast. These include a notable increase in site size and frequency; similar lithic artifact assemblages; and tremendous variations in site size, content, and function. Ward (1983:65) has interpreted this diversity as evidence of an ever-increasing adaptive radiation and specialization in a varied post-Pleistocene environment. Very few Early Archaic sites have been recorded in the Coastal Plain, which may be a result of the inundation of coastal and riverine sites during the onset of the Holocene period (Phelps 1983).

The Early Archaic in the Coastal Plain is subdivided into the corner-notched and bifurcate traditions, and closely follows the Piedmont sequence defined by Coe (1964). Diagnostic artifacts of the first phase of the Early Archaic period (ca. 10,000–9000 B.P.) include Palmer, Kirk corner notched and later stemmed points, and hafted endscrapers (Coe 1964). Kirk phase settlement is characterized by numerous small sites in all environmental zones and suggests an extremely mobile population and a broad spectrum adaptive strategy (Purrrington 1983:113). The later tradition (ca. 9000–8000 B.P.) includes bifurcate forms such as LeCroy, St. Albans, and

Kanawha types (Broyles 1971; Chapman 1975; Claggett and Cable 1982; Oliver 1985). Other Early Archaic period side-notched point forms recognized in the region include Big Sandy (Tuck 1974:75) and Taylor points (Michie 1966), the latter more numerous in South Carolina and Georgia than in North Carolina.

There are contrasting models of Early Archaic settlement, with general agreement that small and highly mobile populations are represented (Griffin 1952:354–355). These models differ in regard to the nature of Early Archaic group mobility and settlement pattern, depending on theoretical perspective. The most inclusive Early Archaic settlement model is commonly referred to as the Band-Macroband model (Anderson and Hanson 1988). Developed from the Savannah River valley data, the model postulates drainage-wide movements in response to seasonal changes in food resources, the need to procure mates, information exchange, and demographic structure. Populations practice a mixed collector/forager strategy depending on the season, and Anderson and Hanson (1988) find evidence for these patterns in the archaeological record. The model focuses on intra-drainage adaptations, and social groups are believed to have crossed into other major drainage valleys only on special occasions for macroband gatherings or aggregations (Anderson and Hanson 1988:270).

Most researchers agree that Early Archaic subsistence focused on white-tailed deer, hickory nuts, and acorns, and utilized both floodplain and inter-riverine upland locations (Gardner 1974:24; Goodyear et al. 1979:28). Subsistence is believed to have focused on more specific resources than in later periods (Cable 1982:687; Caldwell 1958), but this argument is based largely on Caldwell's primary forest efficiency model, which no longer appears to adequately characterize Archaic period developments. Ground cobbles and manos have been found in Early Archaic contexts (Claggett and Cable 1982:37), suggesting processing of plant foods with items that would be more difficult to transport than a biface, but such finds in Early Archaic contexts remain rare (Daniel 1994).

The Middle Archaic, ca. 8000–5000 B.P., can be distinguished from the Early Archaic by the more frequent recovery of groundstone artifacts and a less diverse chipped stone tool kit. Diagnostic bifaces that were made during this period include Stanly, Morrow Mountain, and Guilford types (Coe 1964; Blanton and Sassaman 1989; Phelps 1983). It is assumed that population density increased during the Middle Archaic, but small hunting and gathering bands probably still formed the primary social and economic units. Larger sites tend to occur near major drainages (Coe 1964), but occupations also appear near upland watercourses (Gunn and Foss 1992), and numerous small, dispersed upland scatters are also characteristic of this time period. Utilizing Morrow Mountain point frequencies as a population indicator, Sassaman and Anderson (1994:176) found that the greatest Middle Archaic concentration of population was in the Piedmont region, while the Coastal Plain was virtually abandoned. Other researchers have found that Middle Archaic points, and Morrow Mountain points in particular, outnumber other Archaic types in the northern and southern parts of the coastal region (Daniel and Davis 1996; Davis and Daniel 1990).

The Middle Archaic period is poorly understood in the Coastal Plain. Some researchers interpret this as evidence of a general depopulation of the area. Others argue that Middle Archaic projectile points have yet to be identified in the region (Elliott and Sassaman 1995:26–38).

It is likely that patterns of social relationships changed even in areas not characterized by intensive occupations, especially if Middle Archaic settlement expanded into new areas. The period is characterized by increasing territorial circumscription, even as evidence for continued high mobility remains. It is likely that while Middle Archaic groups were moving as frequently as or more frequently than earlier groups, their movements probably covered shorter distances (Custer 1990:36), a trend that likely became more pronounced in the subsequent Late Archaic period.

As is true of other cultural periods, the Late Archaic (ca. 5000–3000 B.P.) cannot be described by a single pan-Southeast set of traits. The Late Archaic is usually summarized in terms of its most elaborate material manifestations, but these appear to characterize only portions of the Southeast social landscape. Despite abundant local variation, there are some broad themes that serve to differentiate it from preceding periods. The end of the Archaic period in eastern North America is traditionally defined by the development of mineral-tempered ceramic pottery, in contrast to the fiber-tempered ceramics manufactured during the Late Archaic period in the Georgia and South Carolina Coastal Plain (Sassaman 1993).

Late Archaic sites in North Carolina are as abundant in the uplands as in floodplain locations (Spielmann 1976:85), although upland sites may be more visible archaeologically due to erosion and plowing. Some evidence suggests that upland sites do not possess the range of artifact classes present in river floodplain sites, meaning that activities that occurred in upland locations were but a subset of activities that occurred in floodplain locations (this may be true of other periods as well). There are certainly large Late Archaic sites in river floodplains, such as the Gaston, Doerschuk, and Lowder's Ferry sites, and some of these have characteristics of intensive occupations, in the form of occupational middens, high feature density, and circular pit hearths (Coe 1964:119).

In certain major river valleys, including the Savannah, Green, and middle and western Tennessee, there is evidence for intensive shellfish exploitation at shoal areas, accompanied by exchange of non-utilitarian objects, such as engraved bone pins, which perhaps functioned as trade regulators facilitating exchange among culturally circumscribed groups (Ford 1974). These large-scale trade networks appear to be an elaboration of trading networks established during the preceding period (Bender 1985; Marquardt 1985; Sassaman 1995). The Late Archaic period is often linked to higher population densities and increased sedentism (Ford 1974; Steponaitis 1986). In such a situation, mobility became less of a viable economic or social strategy, and one would expect to see increased use of local resources, greater use of storage, and development of formal alliances (Sassaman et al. 1988:81).

Broad, square-stemmed Savannah River points are representative of this period (Clafin 1931; Coe 1964). House and Wogaman (1978) attribute the presence of Savannah River stemmed points in upland locations to hunting-related activities. Some suggest that Savannah River points were more like portable cores from which tools with a variety of functional uses could be manufactured, including spear points (Sassaman et al. 1990:320). This accompanies the viewpoint that Late Archaic populations, being less mobile and more circumscribed by surrounding groups, needed to extend the use lives of stone tools (Parry and Kelly 1987). These points appear to have shown up earlier in the southern portion of the Atlantic coast and were progressively adopted northward (Tuck 1978:38).

Other Late Archaic varieties are known by various names, such as Appalachian Stemmed, Elora, Kiokee Creek, Ledbetter, Limestone, Otarre, and Paris Island (Bullen and Greene 1970; Cambron and Hulse 1983; Chapman 1981; Coe 1964; Elliott et al. 1994; Harwood 1973; Keel 1976; Sassaman 1985; Whatley 1985). Except for the Ledbetter hafted biface, which appears to have had a specialized function—it exhibits a heavily reworked, asymmetrical blade—these latter type names are more a product of parochial terminology than actual morphological differences; they all are characterized by triangular blades, straight or slightly contracting stems, and straight bases.

Steatite vessels, occurring in the form of bowls or crude, shallow pans and a number of other artifact types are also unique to this period, and began to be widely used sometime between 4000 and 3500 B.P. In the central Savannah River valley, use of steatite slabs and ceramic pottery preceded steatite vessel use (Stanyard 2003:54). Steatite vessels were apparently used for slowly cooking plant or animal foods over a direct heat source (McLearen 1991:108).

The most intensively occupied Late Archaic site yet discovered in Georgia is on Stallings Island, located in the Savannah River in Columbia County (Bullen and Greene 1970; Claflin 1931; Crusoe and DePratter 1976; Fairbanks 1942; Jones 1873). One type of bone tool found at Stallings Island is the bone —*pi*,” an artifact found at certain contemporary sites in the Southeast, and representing formalized exchange networks for high-status items. These objects are intricately decorated and highly prized by artifact collectors. Unfortunately, they were —*rimed*” at the site until recent measures were taken to prevent unauthorized access to the site. The mining has devastated the site; large —*pdtoles*” and mining trenches have destroyed much of its integrity.

The Late Archaic lithic tool kit was diverse, and included scrapers, drills, atlatl weights, netsinkers, and grooved groundstone axes. Feature types associated with Late Archaic occupations in North Carolina and Virginia include rock hearths (or heated rock dumps) and small pits (Coe 1964; Idol 2009; McLearen 1991). Stallings Island ceramics were manufactured as early as ca. 4500 B.P. in South Carolina (Anderson et al. 1982).

Reliance on local lithic sources continued, although small frequencies of exotic material, such as chert, demonstrate the extensive economic and social ties of this period. Presumably, steatite for bowl manufacture (or the finished bowls themselves) had to be obtained through trade or direct procurement from the North or South Carolina Piedmont or mountains.

Coastal groups during the Late Archaic are thought to have been fairly sedentary (DePratter 1979; Trinkley 1980). They maintained permanent residences in the littoral zone and made forays into estuarine and interior settings for specific needs. The permanent settlements are recognized as shell rings, while amorphous shell mounds are thought to represent base camps. Interior sites do not have a defining characteristic (Marrinan 1975; Simpkins 1975; Trinkley 1980; Waring and Larson 1968). Interior sites on the Coastal Plain near the project region that are attributable to coastal groups likely served a short-term specialized function. These occupations were generally small and ephemeral; the cultural deposits reflect the specific nature of the occupation, such as a hunting camp.

2.5. FLORIDA

2.5.1. Paleoindian Period

Regardless of the precise timing of the first occupations of North and South America, the current evidence suggests that Florida was not intensively inhabited by humans prior to about 12,000 B.P. Claims for an earlier occupation (e.g., Purdy 1981, 2008) are controversial. The best evidence comes from the Sloth Hole and Page-Ladson sites in Jefferson County, Florida, where radiocarbon dates predating 12,000 C¹⁴ years B.P. have been obtained from levels containing lithic waste flakes, but no diagnostic tool forms (Dunbar 2002, 2006a; Hemmings 1999, 2004). Both sites are inundated river sites, and although the contexts are thought to be intact, there is a possibility of the downward movement of artifacts from the overlying artifact-bearing levels. While archaeologists continue to grapple over routes to the New World, entry points, and the timing of such events, debate also looms over the manner with which the continent was colonized. The use of Geographic Information System (GIS) data has been employed to examine interior routes that would have been preferred based on the ease with which people could have passed (Anderson and Gillam 2000), while others have looked at the distribution of early sites and lithic assemblage variability to advance hypotheses on the peopling of the New World (Faught 2008).

Paleoindian activity is most readily recognized by the presence of the uniquely-shaped lanceolate projectile points that were crafted during the period. Significant work has gone into tracking the location of where these stone tools were recovered, and the PIDBA is an outstanding source for garnering county-by-county data on these specimens (PIDBA 2009). The locational database on this website reveals only nine Paleoindian projectile points recovered from the 13 Florida counties that abut the Atlantic Coast, including four in Brevard, three in Volusia, and one each in Duval and St. John's counties. It is inferred that the Atlantic Coast of Florida did not support significant Paleoindian activity, and this is in part due to the dearth of raw material for stone tool production in this part of the state. Counties that have yielded higher counts of Paleoindian projectile points are within or around Florida's karstic area, such as Gilchrist County, along the Suwannee River, which has yielded the most with 148 specimens reported with PIDBA.

The earliest radiocarbon dates firmly associated with human artifacts in unquestioned contexts indicate people were living in north Florida by at least 11,050 B.P. (Hemmings 2004), during the Clovis phase of the Early Paleoindian subperiod. While distinctive, fluted Clovis lanceolate bifaces have been recovered from several north Florida rivers, only two sites have yielded Clovis points from excavated contexts: the Silver Springs site in Marion County (Neill 1958) and the aforementioned Sloth Hole site in Jefferson County (Hemmings 1999). It is from this latter site that the 11,050 B.P. date was obtained from a Clovis level.

Evidence for occupation of Florida during the subsequent Middle Paleoindian subperiod is much more secure. The diagnostic Suwannee and Simpson lanceolate bifaces are relatively common in north and central Florida, and although no radiocarbon dates have been obtained in association with these artifacts, they are believed to date sometime around 11,000–10,500 B.P. (Goodyear 1999). Two sites have yielded these point types in stratigraphic context: the Harney Flats site in Hillsborough County (Daniel and Wisenbaker 1987) and the Wakulla Springs Lodge

site in Wakulla County (Tesar and Jones 2004). The final subperiod, the Late Paleoindian (10,500–10,000 B.P.), saw the production of both fluted and unfluted forms of Dalton projectile points elsewhere in the Southeast (Goodyear 1982), but evidence for a true Dalton phase in Florida is limited. Dalton points appear to be transitional between the lanceolate forms of the Early and Middle Paleoindian periods and the notched shapes of the Early Archaic period (Ledbetter et al. 1996). Shallow-notched forms such as the Greenbriar point may represent a Late Paleoindian manifestation in Florida.

The climate and landscape during the Paleoindian period were much different from those of today. Not only was it cooler and drier than the present, but coastal sea levels and the inland water table were much lower (Carbone 1983; Dunbar 2002, 2006b; Watts and Hansen 1988). The scarcity of potable surface water sources is thought by some archaeologists to have played a crucial role in the distribution of Paleoindian bands across the landscape (Dunbar 2006b; Dunbar et al. 1992; Faught 2004; Milanich 1994; Neill 1964). They hypothesize that human groups frequented sinkholes and springs to collect water and exploit the flora and fauna that were also attracted to these —oases.” As an added bonus, many of these fresh water sources were located in areas of exposed Tertiary-age limestone that had become silicified, providing Paleoindians with a raw material source (chert) for tool manufacture. Thus, it is thought that permanent fresh water sources (sinkholes, springs), along with locations of high quality chert, were primary factors influencing Paleoindian settlement patterns in Florida.

The conventional view of Paleoindian existence in Florida has been that nomadic hunters and gatherers wandered into an environment quite different from that of the present. Excavations at the Harney Flats site in Hillsborough County (Daniel and Wisenbaker 1987) have altered this view and many archaeologists now believe that Paleoindian people lived part of the year in habitation sites that were located near critical resources such as fresh water.

2.5.2. Post-Paleoindian Period

Around 10,000 B.P., the environment and physiography of Florida underwent pronounced changes due to climatic amelioration. These changes were interconnected and included a gradual warming trend, a rise in sea levels, a reduction in the width of peninsular Florida, and the spread of oak-dominated forests and hammocks throughout much of the state (Milanich 1994; Smith 1986).

Although sea levels rose significantly by the close of the Pleistocene, Early Archaic deposits have been encountered in Florida waters. Some of the better known freshwater sites of this period include Little Salt Springs, Warm Mineral Springs, and Page/Ladson (Milanich 1994; Faught 1996). Assemblages from these sites demonstrate technological change with the introduction of notched, concave-based points (Bolen, Greenbriar or Hardaway) that suggest an adaptation in resource procurement strategy (Faught 1996; Anderson and Hanson 1988). Sport divers have also recovered Early Archaic artifacts in the Santa Fe, Ichetucknee and Wacissa, Aucilla, Steinhatchee, Withlacoochee, and Oklawaha rivers (Milanich 1994).

In the marine environment, Early Archaic Dalton points have been reported in Tampa Bay (Goodyear et al. 1983) and a Bolen point was recovered within 2–6 m of water, approximately 200 m east of the present shoreline at the Douglas Beach Midden site in St. Lucie County

(Cockrell and Murphy 1978; Pepe 2000). Later Early Archaic point types found in the Southeast, such as Hamilton and the Kirk varieties, are surprisingly rare in Florida.

The Windover Pond site in Brevard County is a semi-permanent habitation site that has produced a suite of radiocarbon dates indicating a minimum age of 6,980 B.P. and a maximum age of 8,120 B.P. for burial activities (Doran 2002). Windover Pond has proven to be a crucial site for interpreting Early Archaic lifeways, as its saturated nature and prolonged physical stability have resulted in excellent preservation. There have been 168 human burials excavated from the pond, 91 of which have contained human brain matter, and thus some of the oldest DNA ever examined. These burials were generally flexed and oriented in comparable positions to each other, signifying possible spiritual or religious significance. The ratio of interred males to females and adults (over 20 years old) to subadults were comparable, indicating that all community members were treated in a similar fashion. Preserved stomach contents offered insight into diet. Wood and bone tools were preserved, and most of the burials were staked to the base of the pond and covered with elaborately produced woven fabrics. Environmental reconstruction was achieved through floral, faunal, palynological, and petrographic analysis, and the dates of the semi-domesticated bottle gourd (*Lagenaria siceraria*) were pushed back 3,000 years earlier than what was previously accepted (Doran 2002; Rachel Wentz, personal communication 2009). As the shoreline of 8,000 B.P. was lower than that of modern times, sites comparable to Windover might exist in the shallow waters of the Atlantic Ocean.

The Early to Middle Archaic transition (8,000–7,000 B.P.) is marked by a shift in population from the western side of the state to the eastern, and an increase in site size and frequency (Milanich 1994). At this time, the tool assemblage also changed and projectile points are characterized by convex-based, stemmed point varieties, known as Florida Archaic Stemmed points. Recorded submerged sites with Middle Archaic components are concentrated along Florida's eastern coast and in the St. Johns River area (Faught 1996), in particular, but also are present at Little Salt Spring in Sarasota County and in Tampa Bay (Goodyear et al. 1983; Faught and Ambrosino 2007). Numerous submerged Middle Archaic deposits have also been documented in the Big Bend region north of Apalachee Bay. Sites like the Ecofina Channel, J&J Hunt, and Ontolo illustrate the potential for submerged Middle Archaic remains, which are generally found at depths of approximately 3.5 to 5 m (Faught 2002; Marks and Faught 2003).

Transgression of shorelines generally stopped between 4,000 and 5,000 B.P. As a result, most Late Archaic sites, which post-date this period, were formed after sea levels stabilized. However, coastal Late Archaic sites have been and continue to be susceptible to shoreline erosion and are frequently redeposited from terrestrial to underwater contexts. Minor sea level fluctuations are believed to have occurred around the terminal Late Archaic. Cultural materials could have been deposited at this time when it is believed sea levels temporarily lowered. Late Archaic components have been identified at the Douglas Beach Midden, where in addition to its Early Archaic component, the site yielded a Newnan point and sharpened wooden stakes that dated to Late Archaic ($4,630 \pm 100$ years) at about 7 m depth (Cockrell and Murphy 1978; Pepe 2000). Moreover, the Apollo Beach (Warren 1968) and Venice Beach sites (Koski 1989) both yielded water worn ceramics, in addition to shell tools and chipped stone artifacts.

The close of the Late Archaic, approximately 3,000–2,000 B.P., has also been inferred as a period of lower sea levels. This assertion is based primarily on site distribution and the nature of

sites dating to this period (Ashley 2008; Russo 1992). Ashley (2008:126) points out that only one site dating to this time period is documented in Duval County in the northeastern part of Florida, attributing this minimal site occurrence to “environmental conditions related to sea level fluctuations.” Russo’s (1992:113–114) analysis of the St. Marys region of northeast Florida and southeast Georgia has led him to assert the potential for retreating sea levels during this interval, noting that if this was the case, then sites of the time period might be situated in tidal flat settings whose vegetation and drainage characteristics would have made them more hospitable to habitation at that time. Further to the north, DePratter and Howard (1980) have recognized that many of the Refuge phase sites (3,000–2,650 B.P.) (Thomas 2008:423) of the Georgia coast are in tidal marshes, further substantiating this as a period of low water stand. As such, this interval might represent a period of increased likelihood for encountering submerged pre-Columbian cultural resources. However, this period of lower water levels was likely ephemeral, thus it is suspected that any sites submerged during this interval would likely be close to the present shoreline.

SECTION 2 – CURRENT RESEARCH

3. GULF OF MAINE

This chapter reviews the Maine portion of the Atlantic OCS (Figure 3.1), which is within the Gulf of Maine.

3.1. REGIONAL GEOLOGY

The Gulf of Maine represents the outer edge of the passive continental margin of northeastern North America. In this region, a thick sedimentary sequence is underlain by a series of fault-bounded basins. This series of rift basins, separated by horsts, was formed by the extension and rifting of the Earth's crust in the middle Triassic, creating the proto-Atlantic Ocean. Some of the basins of the Gulf of Maine (Jordan, Crowell, Georges, and Wilkinson) represent surficial expressions of this rift zone (Klitgord et al. 1988). These basins are filled with early Mesozoic terrestrial clastic sediments and volcanic material, and are overlain in places by a thick section of Cretaceous and Cenozoic sediments (Austin et al. 1980; Ballard and Uchupi 1975). The clastic sediments were derived from the weathering of the Appalachian Mountains to the west, and represent both fluvial and shallow marine environments (Austin et al. 1980). In a few locations near Stellwagen Bank, early Cenozoic sediments also crop out on the seafloor (Uchupi 2004).

As the ice sheet retreated, till and glacial-marine sediment blanketed the deeper areas of the Gulf of Maine (Schnitker et al. 2001). These deposits were later re-worked in depths less than about 50 m and covered by Holocene mud in deep areas. Retreating ice reached the Maine coast by about 15,000 calendar years ago (Borns et al. 2004). Near the coast and into the interior of Maine, stratified moraines (moraine banks) were deposited in a general northeast-southwest orientation (Hunter et al. 1996). Glacial-marine muddy sediment covers and is interfingered with the moraines and is an abundant material in the coastal region inland to an elevation just over 100 m (Borns et al. 2004).

The inner continental shelf of the Western Gulf of Maine is divided into six different physiographic regions based on bathymetry, relief and surficial sediments (Barnhardt et al. 2006; Kelley et al. 1998; Kelley and Belknap 1991). The two physiographic zones most relevant to the OCS are the Rocky Zone and Outer Basin. The Rocky Zone is the most spatially extensive area of the Maine inner shelf, and probably the most diverse. It is a region of great bathymetric relief, and is floored by bedrock with subordinate sand and gravel deposits. The Outer Basin is a flat, muddy region that continues from near shore into the deeper Gulf of Maine. Rock outcrops occur within this region, but are relatively small in area (Kelley et al. 1998). The surficial sediment of the seafloor from the Maine coast to the 100 m isobath was mapped by Barnhardt et al. (1996a–1996g). Most of the observational data for the maps was collected within Maine state waters (inside the 3-mile limit). Work that extended into federal waters included the unpublished theses by Lee (2006), Barnhardt (1994), and Shipp (1989).

3.2. RELATIVE SEA LEVEL CHANGES

North of Boston and west of Nova Scotia, the ocean accompanied the retreating glaciers inland. Isostatic depression of the land by the weight of the ice allowed a progressively deeper

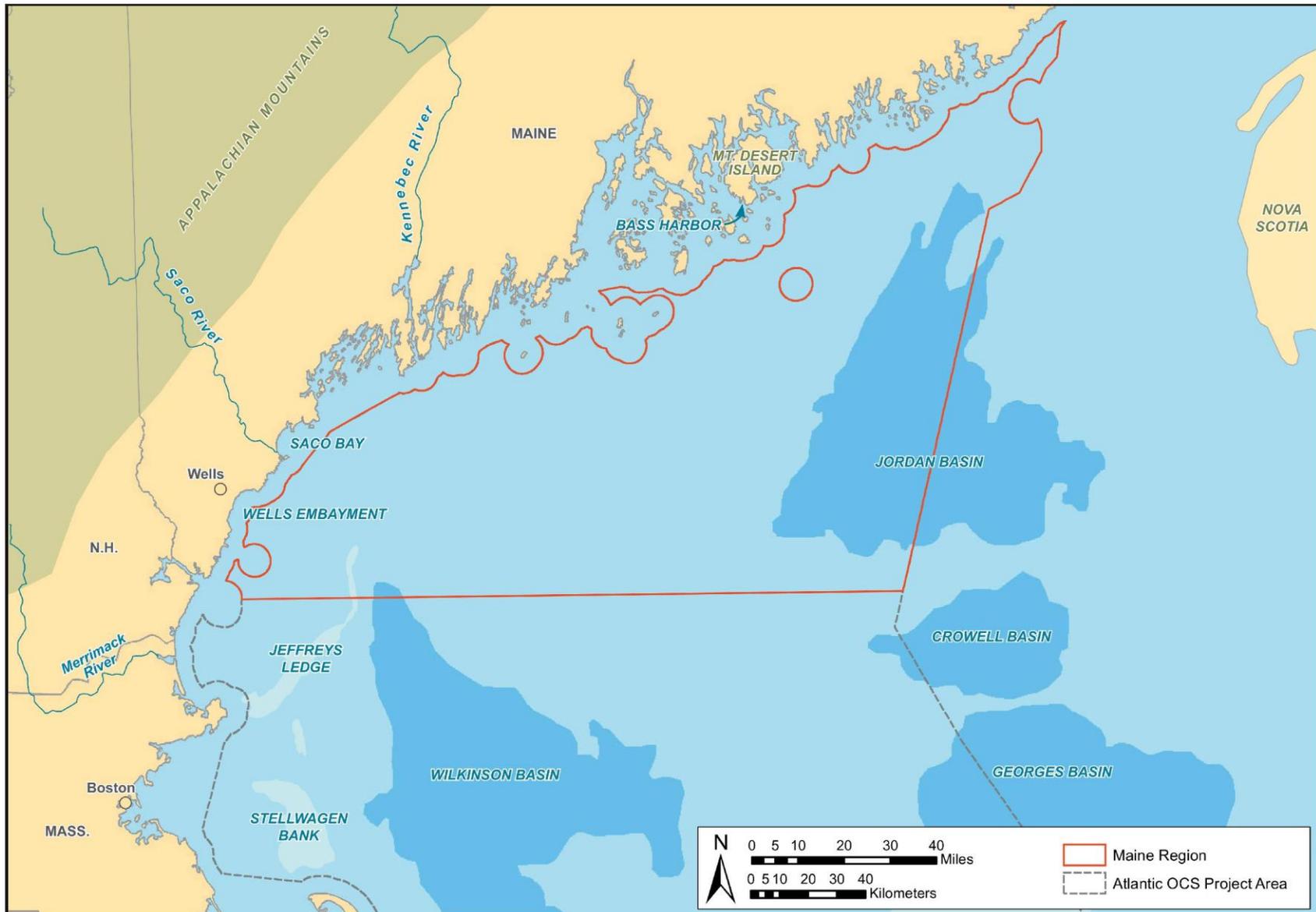


Figure 3.1. Gulf of Maine study region.

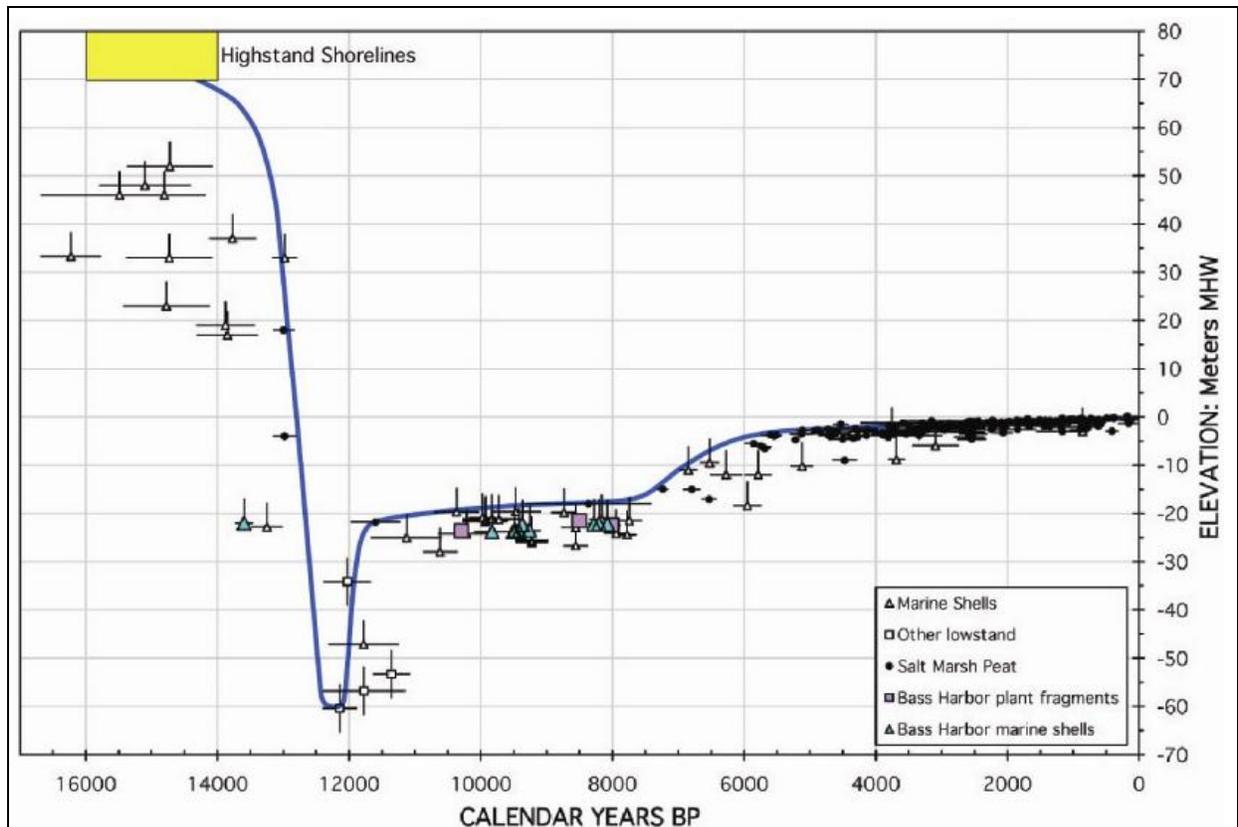


Figure 3.2. Maine relative sea level curve modified from Kelley et al. (2010).

drowning north of Boston, reaching more than 100 m in central Maine (Thompson and Borns 1985). As the ice retreated from Maine, rebound of the land led to uplift of the region and local, relative sea level fell rapidly to a lowstand of about 60 m depth at about 12,500 B.P. (Kelley et al. 2010). The depth of the lowstand was estimated on the basis of drowned shorelines and a drowned delta of the Kennebec River (Barnhardt et al. 1997; Kelley et al. 2003; Schnitker 1974; Shipp et al. 1991). Dates establishing the time of the lowstand were obtained from wood fragments and barnacle plates in cores of Kennebec River delta sediments (Barnhardt et al. 1997) and cores containing *Mya arenaria* and *Mytilus edulis*, intertidal-shallow subtidal organisms, from the lowstand shoreline complex off Saco Bay, Maine (Lee 2006). Figure 3.2 depicts the relative sea level curve for the Maine coast based on these recent data.

To the south of Maine, the Merrimack River paleodelta was graded to a lowstand of about 43 m depth (Oldale et al. 1983). A date from wood fragments in a core here yielded a 12,200 B.P. radiocarbon age, which, if calibrated, was probably slightly older than the Maine lowstand. Another lowstand shoreline was recognized on Jeffreys Ledge at about 50 m depth (Oldale 1985a), and dated to 11,900 B.P. (Oldale et al. 1993). It should be noted that work on sea level to the south of Maine in the Gulf of Maine contains few dated sea-level indicators.

Sea level rose rapidly from lowstand across the Maine continental shelf until about 11,500 B.P., when the rate of rise slowed dramatically (see Figure 3.2). The time between 11,500–7500 B.P. is informally termed “the slowstand” period in the western Gulf of Maine because sea level rose only about 5 m, between 23 m and 18 m depth. Forebulge migration has

been invoked to explain the slowstand (Barnhardt et al. 1995), but part of this time coincided with the catastrophic draining of a glacial lake in Canada at 8200 B.P. This release of water is modeled to have led to uplift in coastal Maine (Kendall et al. 2008), which may have contributed to the length of the slowstand.

Because of the slow rate of sea level rise between 11,500–7500 B.P., coastal processes had time to cause considerable erosion of older, glacial landforms, but the eroded sand and gravel formed numerous beaches and spits (Kelley et al. 2003). These, in turn, provided sheltered environments in which fine-grained sediment accumulated in intertidal and shallow subtidal settings. Many samples of *Mya arenaria*, *Mytilus edulis*, *Crassostrea virginica* as well as *Spartina* sp. and *Zostera marina*, intertidal to shallow subtidal organisms, have been collected by coring from the depth interval and radiocarbon dated to firmly establish the time and depth of this period (Barnhardt et al. 1997; Kelley et al. 1992; Kelley et al. 2003).

It is important to note that the large quantity of datable objects from the slowstand interval resulted from the greater amount of time available when local, relative sea level remained at nearly the same elevation. Coastal storms also had more time to operate at nearly the same elevation during this time, and glacial landforms (moraines, bluffs of glacial-marine mud) were significantly eroded. It was this erosion that provided sand and gravel to build beaches and mud to fill in estuaries and bays. Although the land surface from this time interval must be gone in almost all locations, along with associated archaeological materials, deposits formed below mean high water had an opportunity for preservation. Thus, lake and estuarine bottoms might have been buried as they were drowned. Beaches would have been washed over with increasing frequency as sea level rose across them. Beach migration must have occurred, but the paucity of sediment and abundance of bedrock outcrops doomed the beaches of this period. Only off major river mouths such as the Kennebec and Saco rivers is it likely that beaches migrated into their contemporary positions. In the process of experiencing overwash, beaches may have comeingled human artifacts with washover sediments during their drowning.

After 7500 B.P., sea level initially rose very rapidly. This rapid rise may have prevented complete destruction of constructional coastal features formed during the slowstand period and abetted their preservation. The rise in sea level progressively slowed between 6500 B.P. and the present. Many dates from the base of salt marshes across the State of Maine established the progressive slowing of sea level rise and the uniform behavior of this slowing along Maine's coast (Gehrels et al. 1996).

3.3. MARINE TRANSGRESSION AND SITE PRESERVATION

The OCS off the coast of Maine extends seaward from the state's 3-mile limit to the 100 m isobath along the entire 3,478-mile long shoreline of Maine. The region is a natural continuation of the inner continental shelf of Maine, and much of the material in Kelley et al. (1998) applies here as well. The surficial geological maps of this region (Barnhardt et al. 1996a–g) depict this area, although geophysical data are scarce for portions of the shelf deeper than the 60 m isobath.

Most of the seafloor seaward of the 3-mile limit is contained in the Rocky Zone and Outer Basin physiographic zones (Kelley et al. 1998). Little research has occurred in the Outer Basin because it generally lies beneath the late Quaternary lowstand of sea level (about 60 m). These

areas have remained continuously below sea level since deglaciation (Kelley et al. 1998), so therefore are of little interest for archaeological site preservation insofar as no occupation could have taken place.

In water depths less than the sea level lowstand depth, outcrops in the Rocky Zone were submerged during deglaciation, emerged during the lowstand and were drowned during the on-going transgression. The majority of any sediment covering the bedrock was eroded by waves in exposed areas (Kelley et al. 2010). Some exceptions to that pattern may exist, however, where outer shelf regions that were once terrestrial (shallower than 65 m) may be preserved. Such areas may include regions seaward of the Saco and Kennebec River mouths, as well as areas within the Wells Embayment where, because of the large volume of sediment derived from rivers during the lowstand of sea level, some former terrestrial habitats may still remain (Figure 3.3).

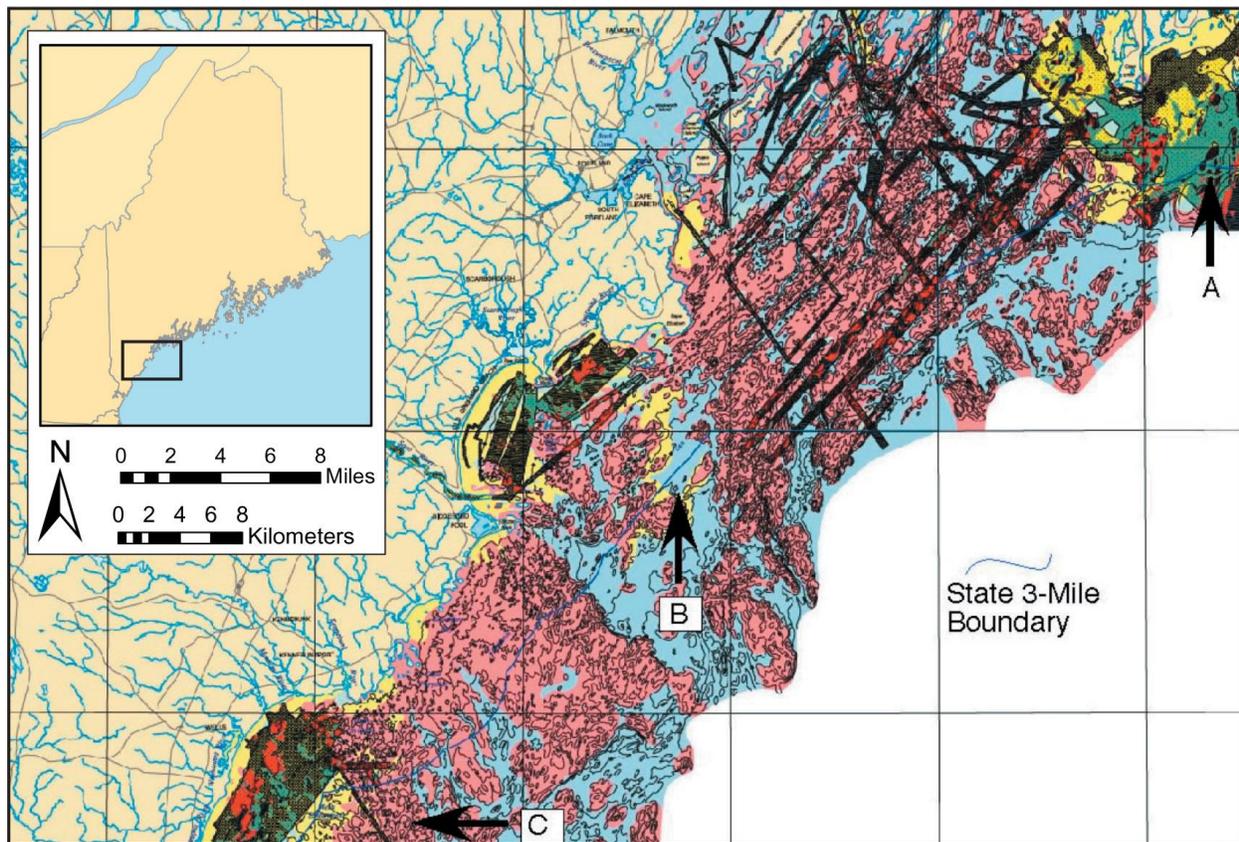


Figure 3.3. Inner Continental Shelf map of southern Maine (Barnhardt et al. 1996a–1996c). The dark blue line marks the state 3-mile boundary. Bathymetry shown by black lines. Yellow represents sand deposits; blue, mud; red, rock; and green, gravel. Darker shades of the colors show areas with geophysical data, while lighter shades represent inferred bottom type. Location A points to the paleodelta of the Kennebec River. A seismic line near point A is shown in Figure 3.4. B points to a seismic line off Saco Bay and is shown in Figures 3.5 and 3.6. Location C points to the Wells Embayment.

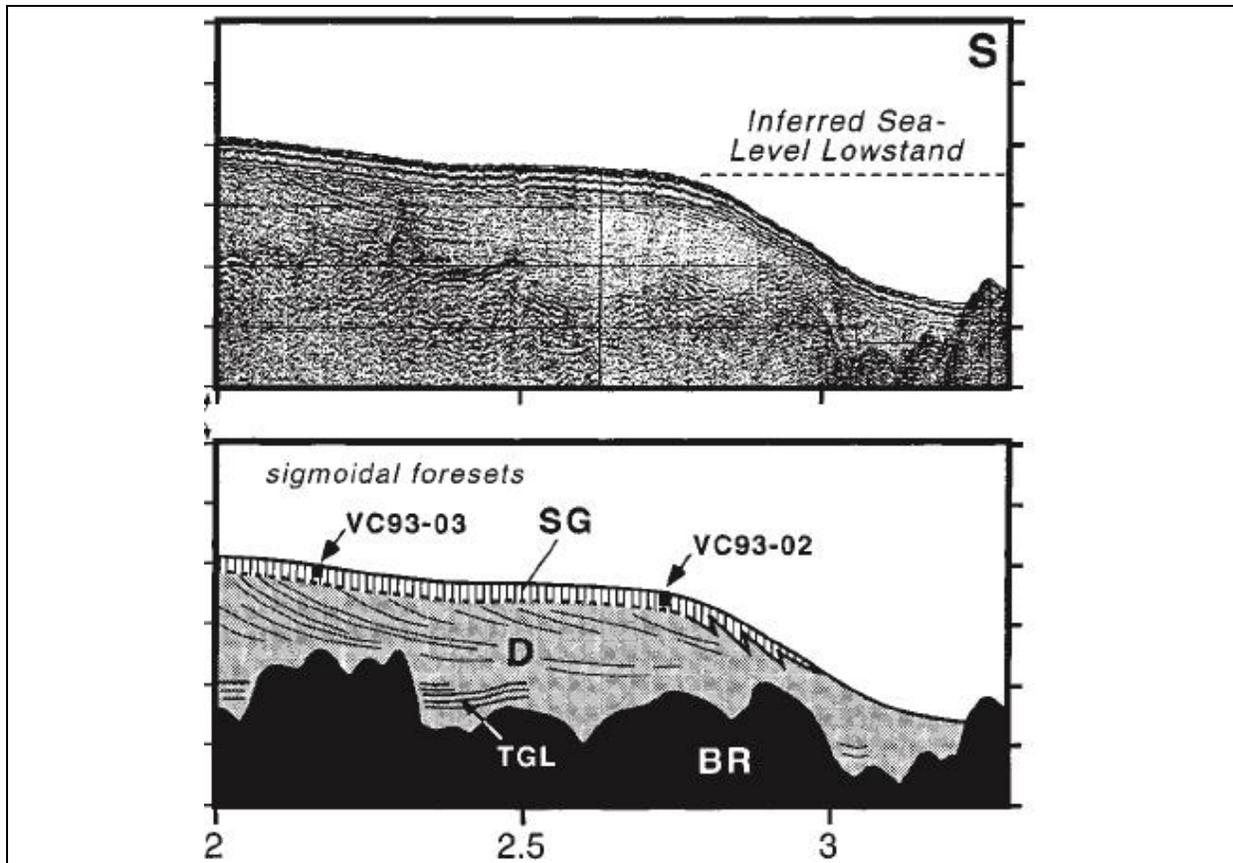


Figure 3.4. Seismic reflection profile located near Point A in Figure 3.3 (from Barnhardt et al. 1997:Figure 8). BR indicates bedrock; TGL represents Thin Gravel Layer; D indicates Delta; SG indicates Sand and Gravel. VC93-02 and VC93-03 are vibracores that contained all sand and gravel.

Off the modern Kennebec River, a vast sand and gravel plain extends into federal waters (see Figure 3.3). This landform is a paleodelta that was deposited as sea level fell to the lowstand (Barnhardt et al. 1997). The most seaward parts of the delta were riverine environments that may well have hosted early human immigrants. The rising level of the ocean eroded much of the area (Figure 3.4), however, and acoustic reflectors interpreted as deltaic clinoforms are truncated by a condensed Holocene section. There has been no research in this region since Barnhardt's 1990s work (Barnhardt et al. 1997), and there may be preserved sites that were sheltered near bedrock outcrops that protected them from the brunt of marine transgression.

In outer Saco Bay, some sandy deposits from the depth/time of the lowstand also occur in federal waters (Lee 2006). Early work supported by the Minerals Management Service (Kelley et al. 2007) identified sand deposits surrounding rock outcrops in 50–70 m water depth (Figure 3.5). More detailed seismic reflection observations coupled with vibracores found Holocene sand unconformably overlying Pleistocene glacial-marine muddy sediment (Figure 3.6). Dates from intertidal fauna (such as *Mya arenaria* and *Mytilus edulis*) in 60 m depth led to a recognition that the lowstand of sea level occurred about 12,500 B.P. (Lee 2006). Again, alluvial deposition may have sealed archaeological deposits and protected them from subsequent erosion during transgression.

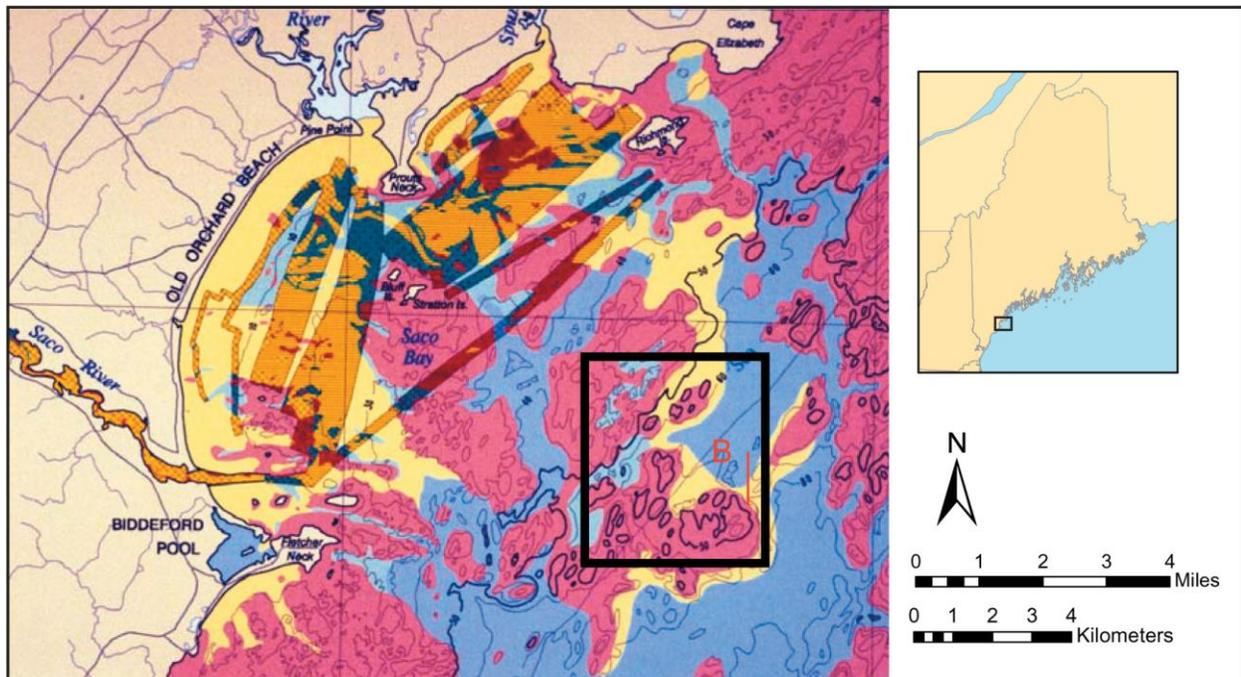


Figure 3.5. Inner Continental Shelf map off Saco Bay in southern Maine (Barnhardt et al. 1996b). Location B is the same location represented as B in Figure 3.3. The red line beside B is the location of a seismic line shown in Figure 3.6. Colors are the same as in Figure 3.3.

Likewise, off Wells Embayment, sand deposits are also associated with possible lowstand shoreline positions (see Area C in Figure 3.3) (Shipp 1989; Shipp et al. 1989, 1991; Kelley et al. 2003). These features have never been studied in detail and no cores exist from this area.

In other areas near the Wells Embayment where the lowstand position of sea level lies in federal waters, there are no observations available to evaluate the seafloor. No work has occurred in these areas because the highly exposed nature of the region and likely paucity of sediment. Archaeological sites are unlikely to be preserved in such settings because of this lack of sediment.

Drowned terrestrial prehistoric sites with archaeological potential are probably focused between the 15–25 m depth range, the depth range encompassed by the slowstand of sea level, and the 55–60 m range, the sea level lowstand position. Because of the relatively steep, bedrock-controlled bathymetric gradient, there are few locations along Maine’s OCS coast in the 15–25 m range. Because of the irregularity of the bathymetric relief associated with bedrock, there are not long, continuous stretches of OCS land at the lowstand depth.

There are particular exceptions to the model for site potential based on bathymetry. Specifically, locations where unique landform configurations enclosed and protected areas from wave action so that inundation took place by water spilling into the enclosed setting. The existence of such protected environments came to light after scallop draggers discovered Middle Archaic stone tools from off Mt. Desert Island, Maine, from about 20 m depth (Price and Spiess 2007), prompting a geophysical and coring study of the site (Kelley et al. 2010). The shoal from

which the artifacts were recovered is a partially eroded morainal complex with spits attached at the ends and connecting the moraines (Figure 3.7). Seismic reflection profiles revealed multiple acoustic reflectors within the spits that were correlated with lithologic changes in cores. The spits unconformably overlie glacial-marine mud in seismic profiles, but cores could not penetrate past a sandy, muddy gravel with abundant *Crassostrea virginica* and *Mya arenaria* shells. This unit was abruptly overlain by a mud deposit with abundant *Zostera marina* stems lying on bedding planes. Graded beds of sand and gravel with fragments of peat containing freshwater diatoms

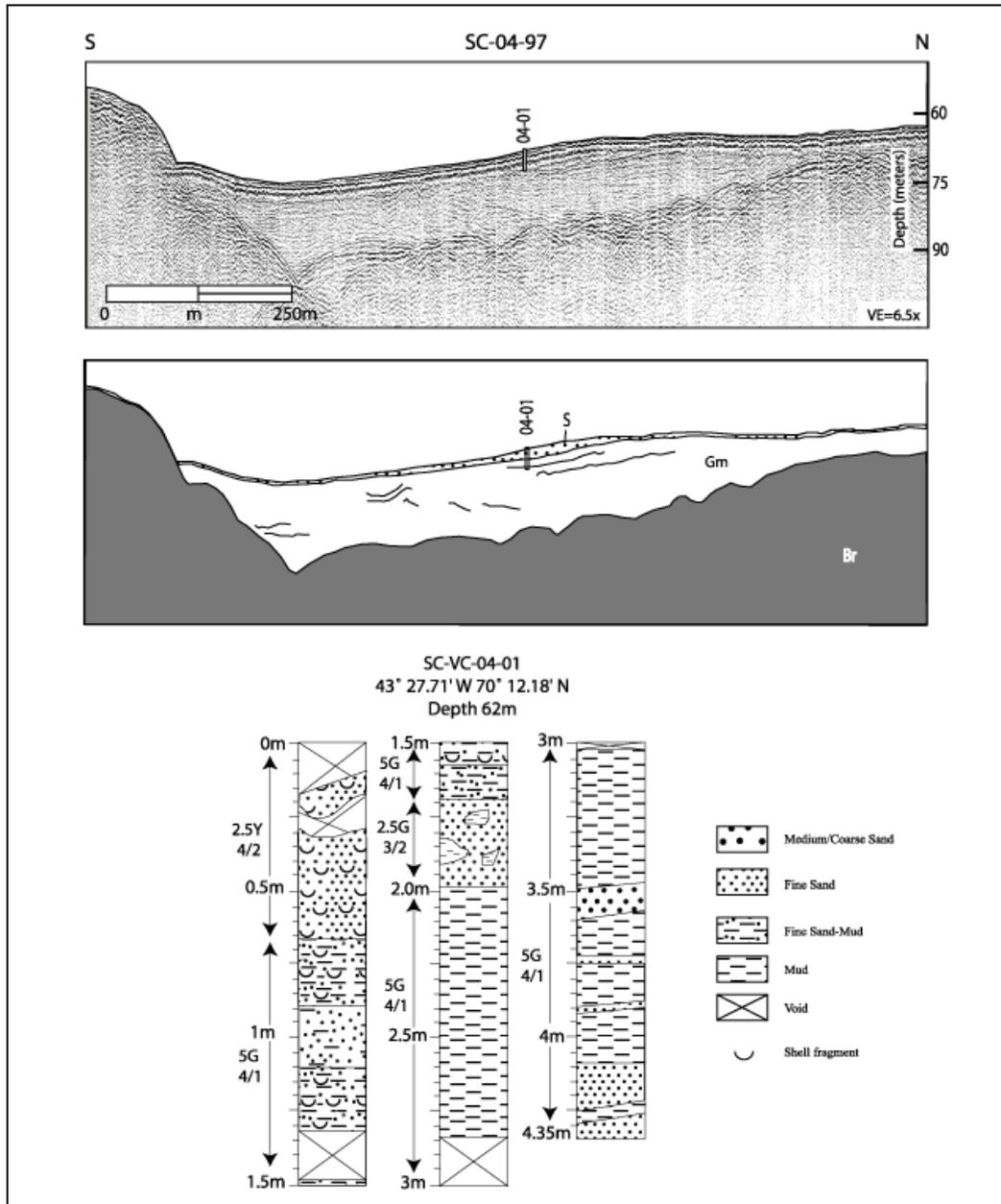


Figure 3.6. Seismic line indicated near B in Figure 3.5 (from Lee 2006).

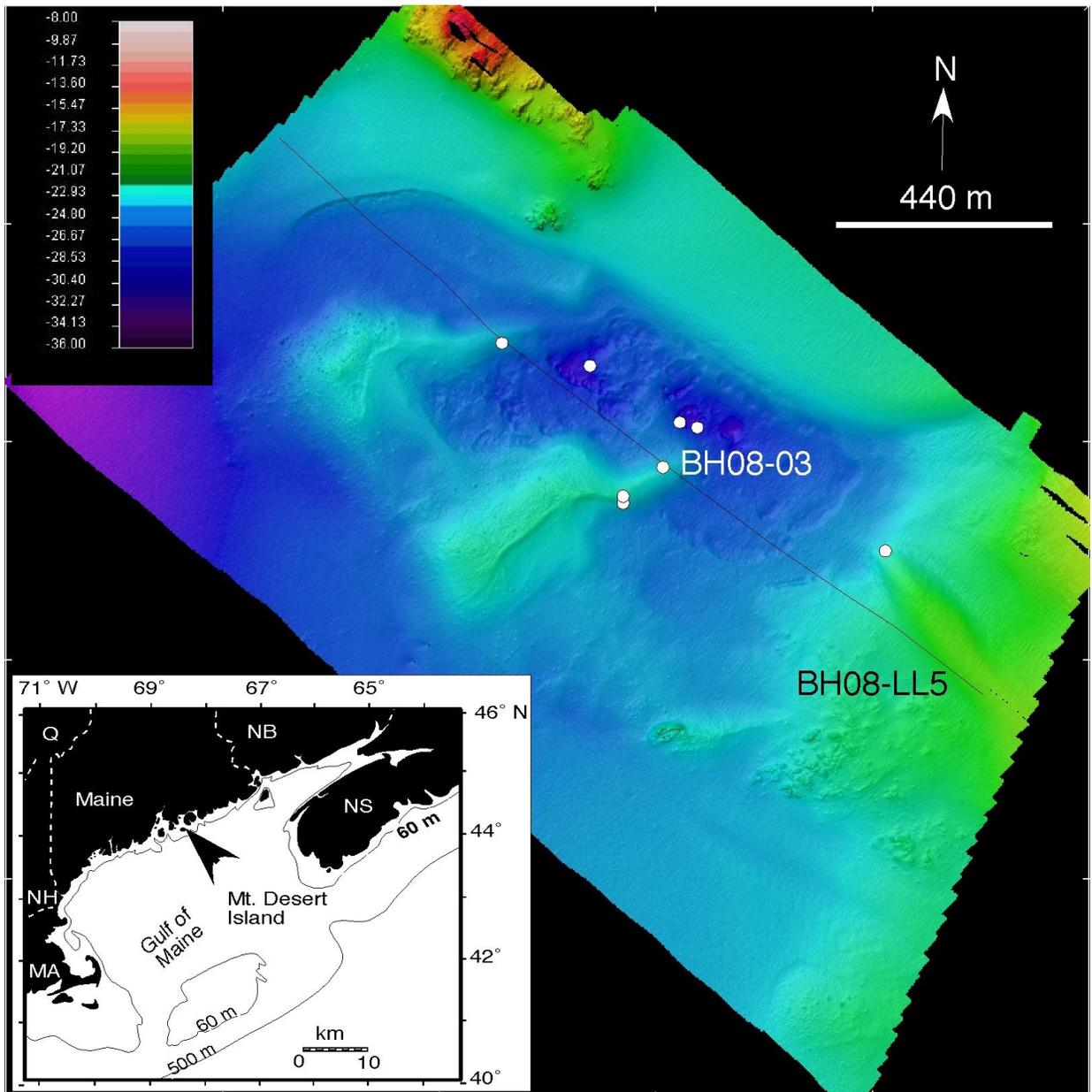


Figure 3.7. Multibeam image of submerged Bass Harbor morainal spit complex. Middle Archaic artifacts have been recovered by draggers in this area. Modified from Kelley et al. (2010).

capped the section through the spit. This overall stratigraphic section reflects medium energy marine conditions (sandy gravel with oysters) that became suddenly very low energy (mud with *Zostera*) probably as a consequence of increased shelter from waves by spit growth. Rising sea level finally began washing gravel, shells, and freshwater peat blocks onto an accreting tidal flat before the entire area drowned. All of the calibrated dates from the shells, peat fragments, and *Zostera* fell within the slowstand interval (11,500–7500 B.P.). Where similar protected settings exist, intact archaeological deposits are possible.

In the case of bedrock-sheltered embayments like Bass Harbor, various environmental settings would have existed prior to inundation, and when more detailed data is available from coring, it can be possible to further refine predictions about where archaeological sites might be found. Areas that consist of mud sea floors—representing likely mud/tidal flats when subaerial, with the mud likely the result of bluff retreat or re-suspended sediment from the erosion of tidal flats as sea level rose—have no potential for having contained archaeological sites when the area was subaerial. However, associated higher areas may have hosted sites because they provided occupation areas close to a food source. Thus, what would have been higher elevations in locations now above the 60 m isobath have some potential as site locations prior to inundation.

In other areas, extensive muddy bottoms lie near the lowstand depth and in federal waters, but represent the retreat path of bluffs of glacial-marine sediment and tidal flats. As such, these locations would not hold much promise for preserving drowned terrestrial sites *in situ*. Similarly, off the Kennebec River paleodelta, sandy former deltaic areas are common (Barnhardt et al. 1997). However, these areas were transgressed by migrating barrier islands and spits, which would have eroded any former archaeological sites.

It is important to note that existing bathymetry is not always capable of resolving potential sites. The Bass Harbor site was a minor shoal on the nautical chart (Kelley et al. 2010). In other locations, detailed surveys have revealed locations with great archaeological potential that the nautical chart did not even hint at (Figure 3.8). The dark areas in Figure 3.8 are moraines that were barrier islands on two occasions: once before the lowstand, around 13,000 B.P., and prior to drowning about 8000 years ago. During those times, they may have been occupied and when drowned, materials may have been buried and preserved. Features like this may be common in the offshore area in water less than 60 m deep, but they cannot be recognized on nautical charts or old bathymetric charts based on lead soundings.

All areas off the coast of Maine do not hold out equal probabilities of preserving terrestrial environments and/or archaeological sites. The lowstand of sea level is well established at about 60 m depth, but is not as well constrained chronologically. Only a few *Mya arenaria* dates from outer Saco Bay are reliable sea level indicators (Lee 2006); none of the wood fragments and other shell dates from the Kennebec River paleodelta are related to tidal elevations. Thus, the lowstand, a time when isostatically emerging land coincided with eustatic sea level rise, may have lasted for hundreds of years. Such a long period of sea-level stability, as during the slowstand, could have led to beach formation and the creation of wetland habitats attractive to humans. No such localities have been found, however, possibly because most research in the slowstand area has been off large river mouths (e.g., the Kennebec and Saco rivers) where sediment deposits bury basins formed by bedrock or glacial deposits.

3.4. ARCHAEOLOGICAL SENSITIVITY AND PRESERVATION POTENTIAL

Based on the most current sea level curves for this region, archaeological sensitivity is defined as follows:

- No Sensitivity. Areas 60 m and greater in depth are considered to be areas with No Sensitivity for prehistoric sites, since these areas were not subaerial during the LGM.

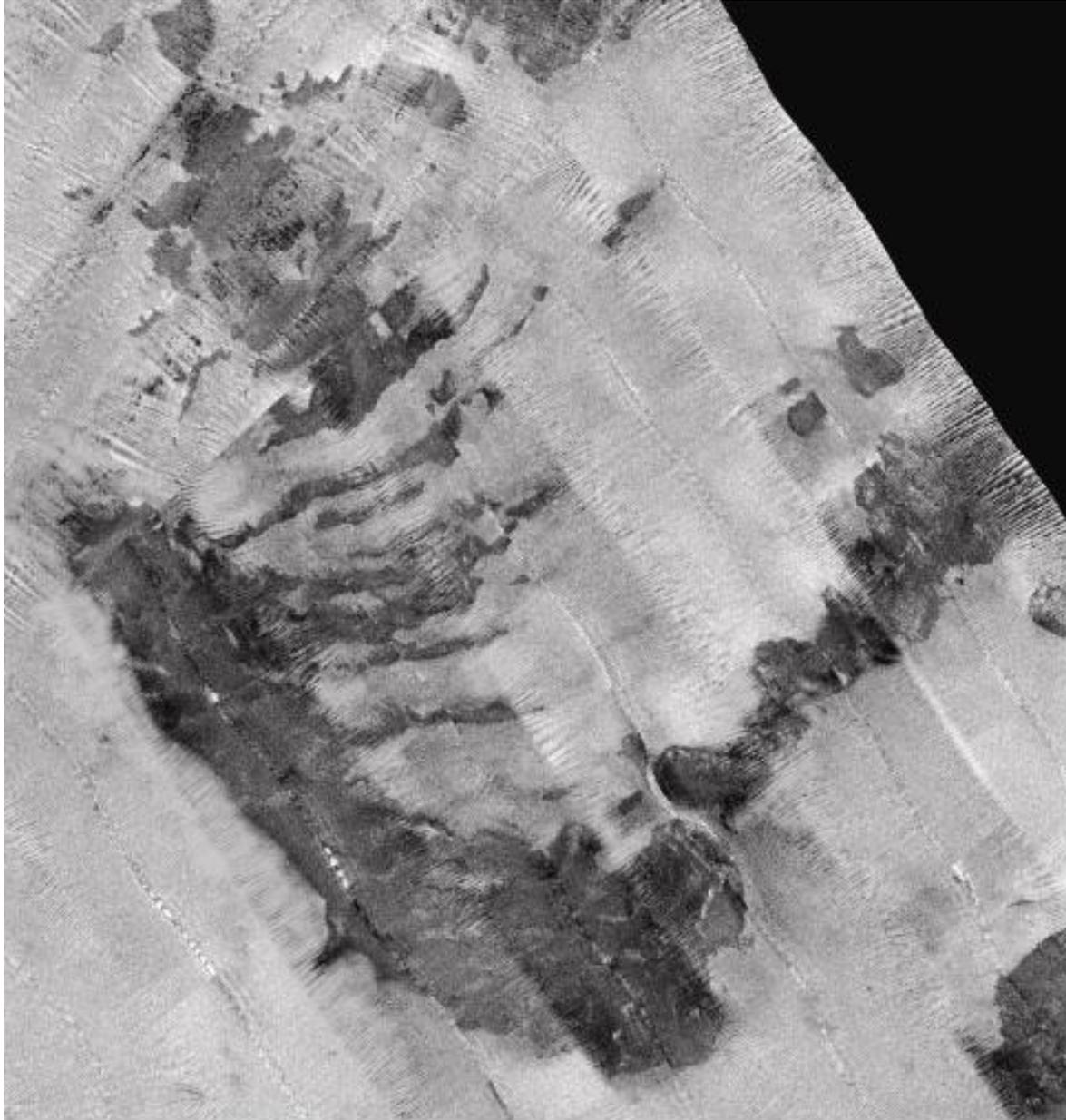


Figure 3.8. Side scan sonar image of moraine complex approximately 5 km offshore of Wells, Maine. Dark areas show highly reflective bottom types (till, gravel). Similar features are likely to exist beyond Maine's 3-mile limit in federal waters. Modified from Kelley and Belknap (2003).

- Low Sensitivity. This designation intends to cover areas exposed between the time of the LGM and the earliest Clovis occupation. Given that the lowstand occurred at approximately 12,500 B.P., which marks the beginning of the Paleoindian period, there are no areas that fall in the Low Sensitivity designation for this region.
- High Sensitivity. High Sensitivity areas include all areas within the OCS that are shallower than 60 m.

As discussed in the previous section, submerged prehistoric archaeological sites on the Maine OCS will be from the current coastline to a depth of 60 m, and may be found in either inundated terrestrial or coastal environments (Figure 3.9). In the Late Pleistocene, terrestrial environments extended to the 60 m isobath. As sea-level began to rise, coastal environments moved landward across the previously subaerial landscape. Thus, rising sea levels created a landward-moving mosaic of terrestrial and coastal settings. High potential terrestrial sites will be those that offered living space associated with resource-rich environments: wetland edges (fresh and salt), river and stream courses, and lake margins. Coastal sites will be areas that offer protection from wind and waves (bedrock sheltered embayments) and occupation sites with access to floral and faunal resources (beaches on spits, moraine crests, or beaches fringing islands).

As is illustrated in Figures 3.10–3.13, site preservation potential is most likely to be best at 55–60 m depth (lowstand) and between 15–25 m (associated with a regional “slowstand” of sea level). Although slow sea level rise is likely to erode sites, the lowstand and slowstand periods represent times when beach formation and wetland development would have attracted people (e.g., Almquist-Jacobson and Sanger 1995; Nicholas 1998), and some of these lower-situated sites may have been preserved when spits formed below the surface and helped protect the sites from marine transgression. During the lowstand, for example, there was possibly sufficient time to allow burial of material to a great enough depth (thickness of deposit) that a site may have survived transgression. Such would only have been true in areas of rapid sediment accumulation, such as a delta, and/or moderate sediment accumulation but with shelter from large, erosive waves.

Areas with High Preservation Potential for this region likely include regions seaward of the Saco and Kennebec River mouths, as well as areas within the Wells Embayment where, because of the large volume of sediment derived from rivers during the lowstand of sea level, some former terrestrial habitats may still remain. In such areas, sites near the ocean or in deltaic wetlands may have attracted people, and sites may have been buried deep enough to survive transgression.

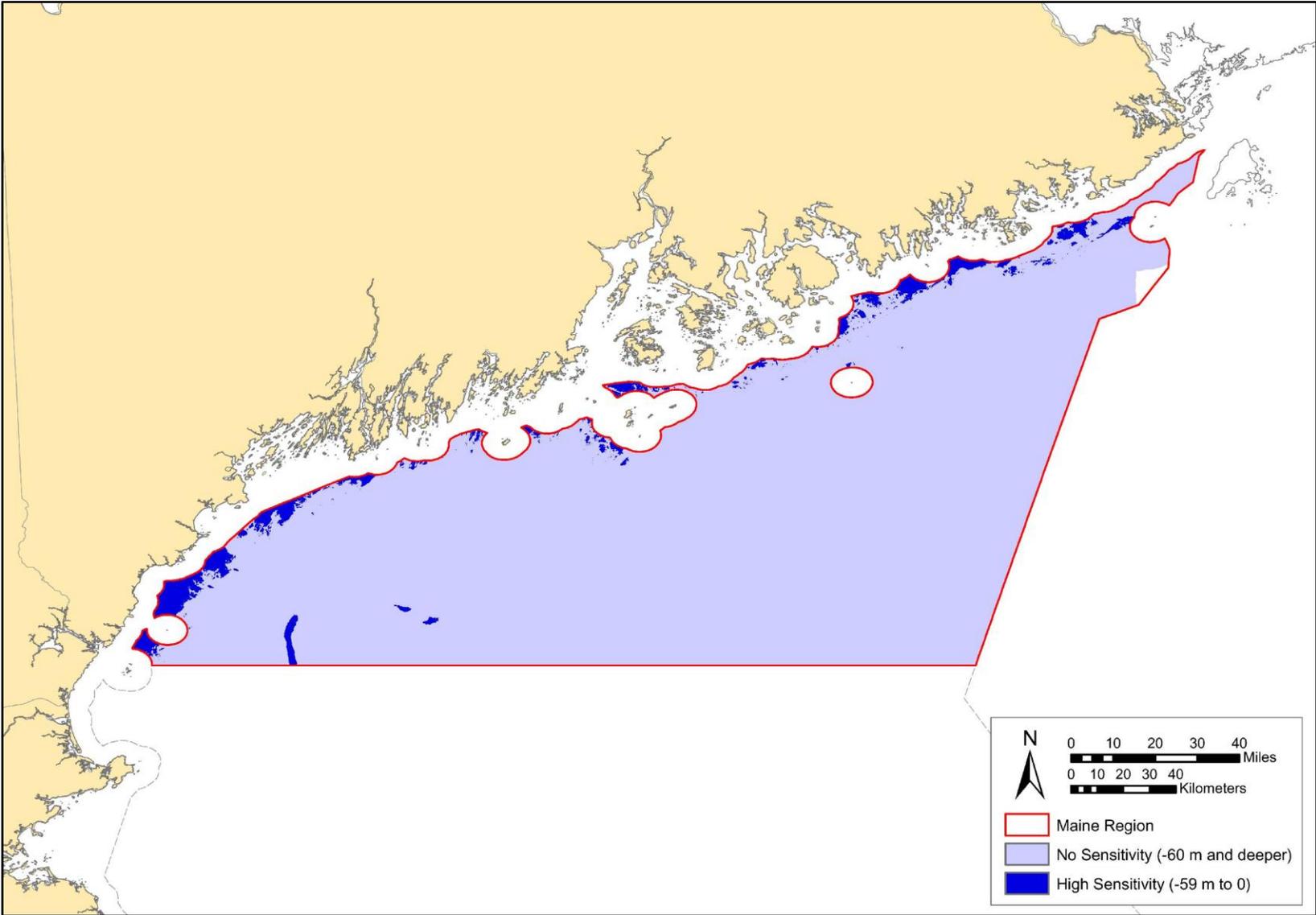


Figure 3.9. Archaeological Sensitivity map for the Gulf of Maine study region.

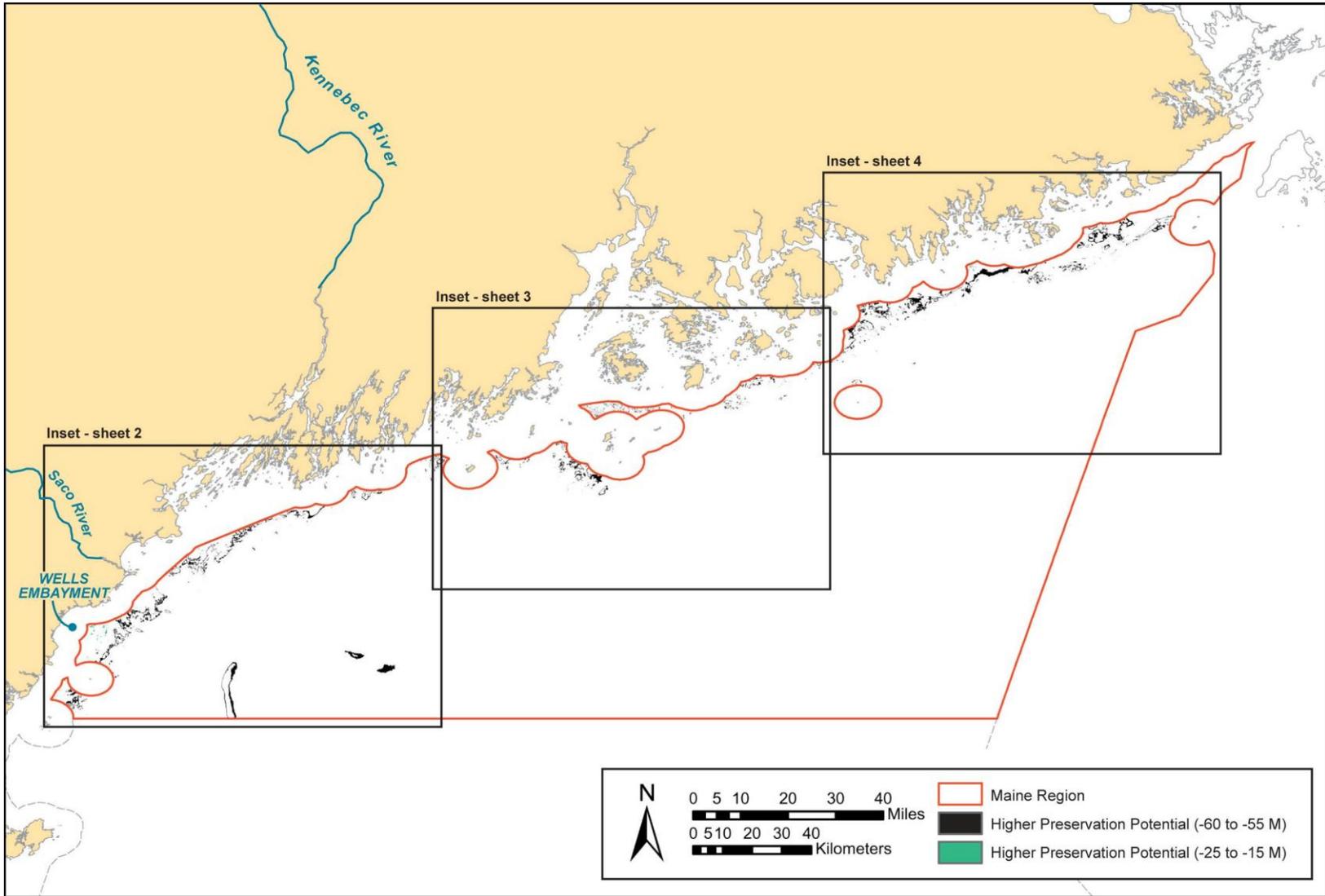


Figure 3.10 (Sheet 1 of 4). High Preservation Potential areas for the Gulf of Maine study.

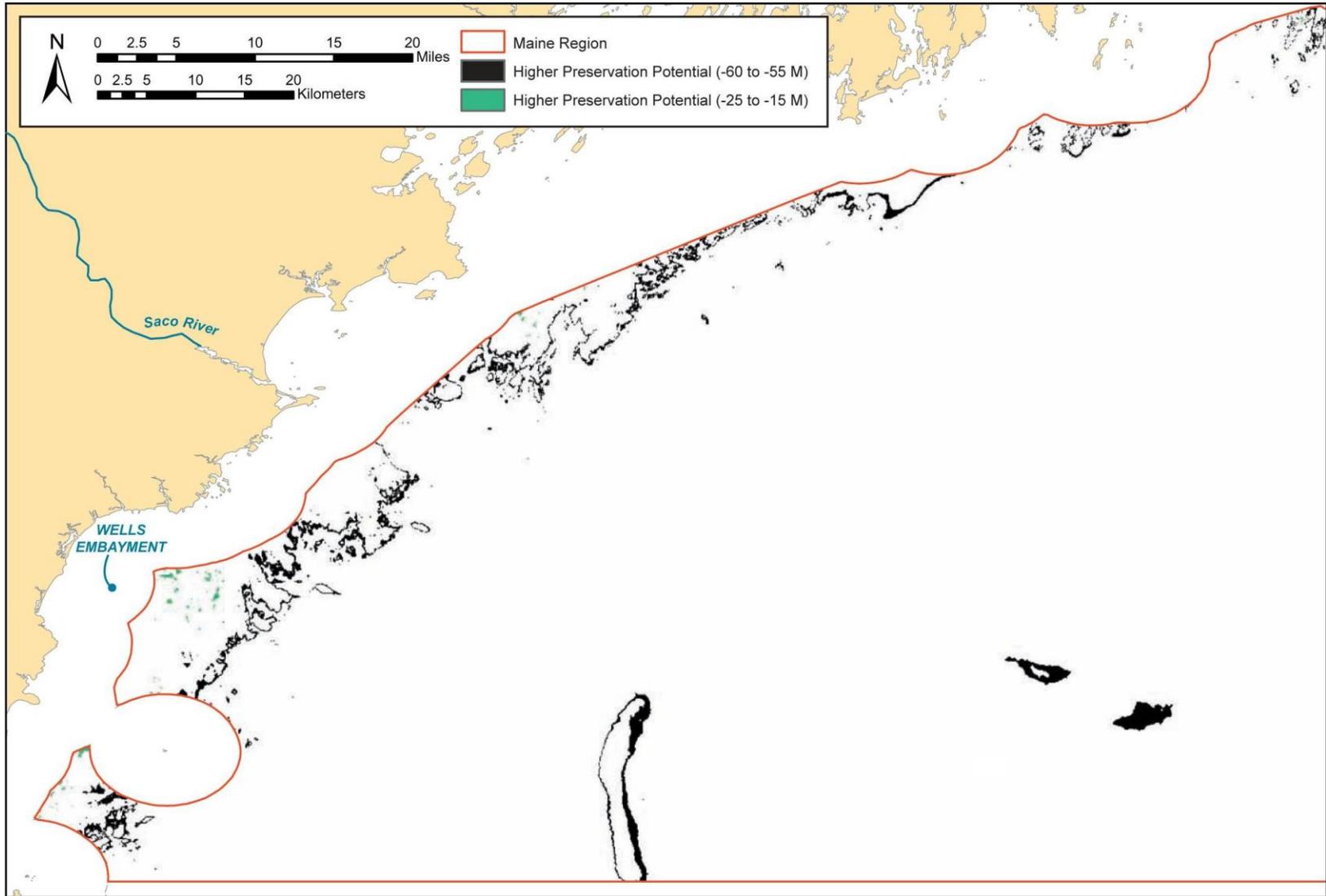


Figure 3.10 (Sheet 2 of 4). High Preservation Potential areas for the Gulf of Maine study.

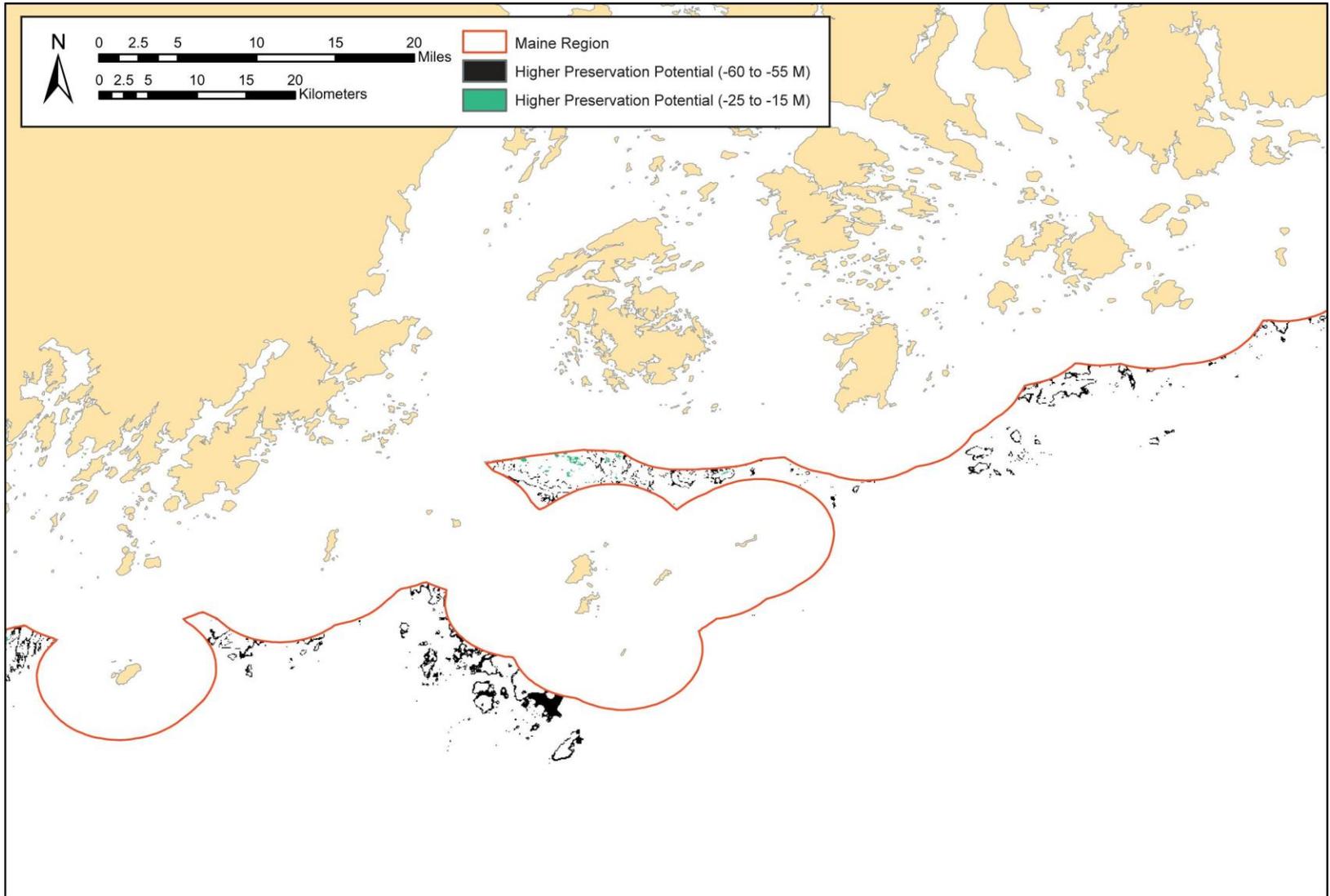


Figure 3.10 (Sheet 3 of 4). High Preservation Potential areas for the Gulf of Maine study.

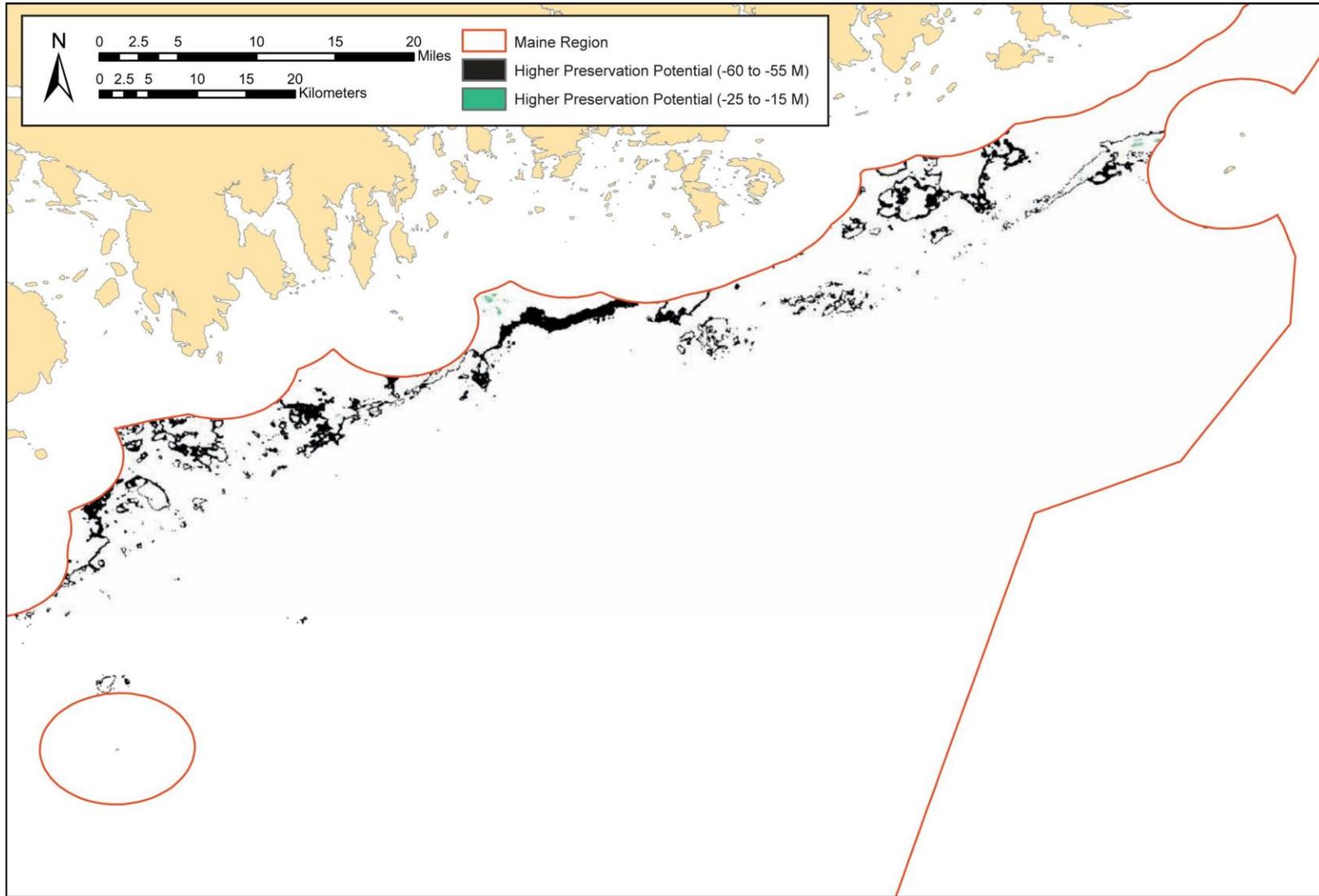


Figure 3.10 (Sheet 4 of 4). High Preservation Potential areas for the Gulf of Maine study.

4. SOUTHERN NEW ENGLAND AND THE GEORGES BANK

The study area for this chapter includes the geographic region called Southern New England and the Georges Bank. It is located within the North Atlantic Planning Area, south of the coast of Maine (Figure 4.1).

Environmental settings, environmental conditions, and natural resources are important factors to consider when assessing the potential for the presence of archaeological deposits that are associated with human habitation sites inundated by eustatic or glacially-related sea level rise. As Renfrew (1976) notes, —because archaeology recovers almost all of its basic data by excavation, every archaeological problem starts as a problem in geoarchaeology.” The complexity and variability of geological processes in general make every region or site unique, and sediments comprising the massive expanse of seafloor within the Southern New England–Georges Bank (SNE-GB) study area are no exception. Having a basic understanding of the varied, evolving and dynamic geomorphology of the submerged landscape within this area, approximately 40 percent of which was once shallow enough to be exposed land available for human occupation prior to its inundation and transformation into part of the North Atlantic continental shelf, is essential for assessing the SNE-GB study area’s pre-contact period archaeological sensitivity.

4.1. REGIONAL GEOLOGY

The geological history most relevant to the discussion and assessment of the pre-contact period archaeological sensitivity of the SNE-GB study area is that of the Late Quaternary period spanning the last 20,000 years and encompassing the Late Pleistocene and Early Holocene epochs and southern New England’s nearly 12,000 years of archaeologically documented human history. This period in time is marked by three major geological events: glaciation; ice retreat; and sea level rise. While the basic structure of the southern New England coastline and the adjacent continental shelf were created by glacial scouring and transport and the subsequent erosion of sediments during glacial melting and retreat, secondary processes of relative sea level rise, wave and tidal erosion, and subaqueous sorting and transport of sediments have further transformed the geomorphology of the land-sea interface and the sea floor within the SNE-GB study area.

This region is closely tied to the geological development of the Gulf of Maine to the north. West of the Great South Channel, the shelf materials extend onto land as the Coastal Plain (Thornbury 1965). The Georges Bank is an extension of these Coastal Plain sediments, but is separated from the Appalachian Mountains by the almost 400-m deep waters of the Gulf of Maine (Uchupi 1968). The removal of Coastal Plain materials from the Gulf of Maine is presumed to be a consequence of a series of Pleistocene glaciations (Uchupi 2004).

The terminal moraine of the Laurentide Ice Sheet (LIS) formed as the most recent ice advance reached its southernmost extent approximately 23,000 years ago (Balco et al. 2002; Denton and Hughes 1981). The moraine is located approximately 400 km to the south of Maine at Long Island, New York, and roughly coincides with the southernmost area of bedrock exposure (Uchupi 1970; Uchupi et al. 2001). While still a prominent portion of the Long Island,

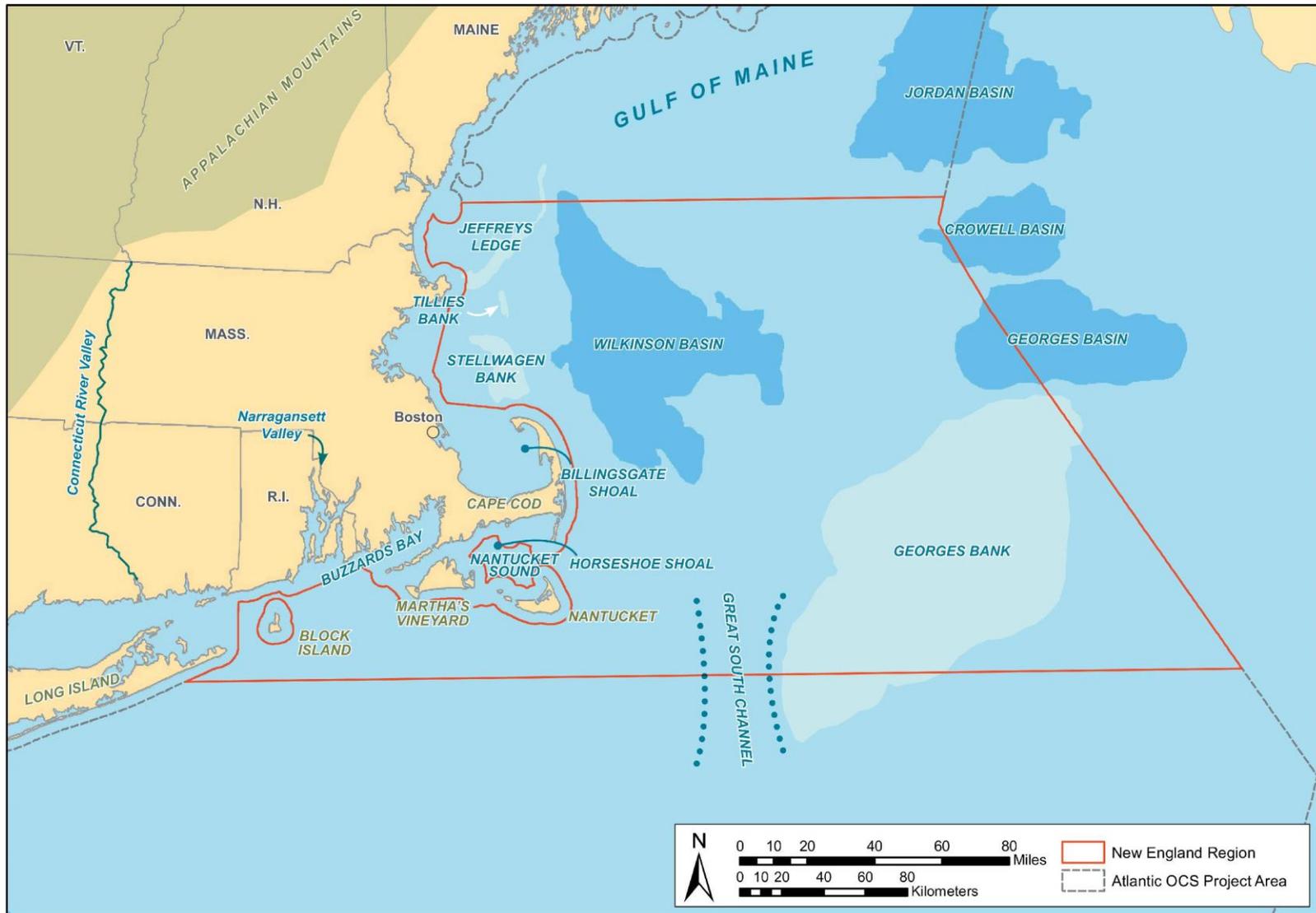


Figure 4.1. Southern New England–Georges Bank study region.

Nantucket, and Martha's Vineyard landscape (Balco et al. 2002; Hartshorn et al. 1991), the moraine no longer has a significant bathymetric expression as it extends east across Georges Bank. Reworked by waves and tides, the Georges Bank portion of the moraine is recognized largely by the distribution of gravel (Schlee and Pratt 1970).

Charted water depth within the SNE-GB study area today ranges from a minimum of about 5.5–10 m to a maximum of approximately 2,012 m. Average depth across the entire study area is calculated at approximately 120 m. Approximately 20,000–18,000 years ago, however, sea level was estimated to have been approximately 90 m lower than present, and the vast majority of the OCS was subaerial (Oldale 1985b; 1985c; Pirazzoli 1991; Uchupi et al. 2001). This was a time when the LIS associated with the Wisconsin glaciation had advanced southward to its terminal position, corresponding with the terminal and recessional moraine formations of poorly and well-sorted glacial till (i.e., boulders, rocks, gravel, sand, silt, and clay).

The LIS that spread across the SNE-GB study area was characterized by bulges or “lobes” in the ice front that filled in the large basins of the existing, pre-glacial, topographic surface. The four lobes that occupied the SNE-GB study area (from west to east) along the LIS front were the Connecticut Valley Lobe, the Narragansett-Buzzards Bay Lobe, the Cape Cod Bay Lobe, and the Great South Channel Lobe. The advance and retreat of these lobes led to the formation of morainal deposits of glacial till consisting of soil, sediments, decomposed rock, and fragmentary bedrock collected by the ice as it flowed southward across the region and formed Long Island, Block Island, Cape Cod, Martha's Vineyard, and Nantucket Island. Sloping away, south and east of these morainal structures was an extensive outwash plain formed by deposits of finer materials carried away from the ice sheet lobes in meltwater flows. North of these morainal structures and Cape Cod, banks, basins and deep troughs cut by ice streams left the shelf more topographically irregular and created Stellwagen and Tillies banks, Jeffreys Ledge, Race Point Channel, Stellwagen and Scantum basins and the Massachusetts Shelf. East and south of Cape Cod, outwash from the melting Cape Cod Bay and South Channel lobes deposited vast plains of sand and gravel which today comprise Nantucket Shoals and Georges Bank (Oldale 2001a, 2001b). Sloping of these sediments led to a gradation in sediment sorting and a decrease in elevation of the plain moving away from the moraines' topographic highs.

After reaching its apex ca. 18,000 B.P., the Wisconsin glaciation began receding because of a climatic shift towards a cycle of global warming. Meltwater from the shrinking ice sheets was funneled into rivers and returned to the world's ocean basins.

Runoff from the melting ice sheet was also trapped behind the region's terminal and recessional moraines that acted like earthen dams, thus producing a series of proglacial lakes covering an area 21,235 square miles in size with a combined volume of 132 cubic miles of water, assuming an average lake depth of 10 m (Uchupi et al. 2001). Uchupi et al. (2001) have argued that some of the depositional and erosional features on the OCS, including within the SNE-GB area, were produced by catastrophic discharges of large volumes of water from these proglacial lakes over about a 5,000 year period, which in some cases transported coarse debris via gravity flows across hundreds of miles of the shelf and into the deep sea. They also have argued that the visibility of these catastrophic morphologies suggests that much of the surface of the OCS was little modified by the late Pleistocene–early Holocene marine transgression,

possibly because a rapid rise in sea level allowed for preservation of relict features (Uchupi et al. 2001).

By 14,000 B.P., southern New England was free of glacial ice and by 12,000 B.P. nearly all of New England had become open to plant colonization (Jones 1998). Deglaciation heavily reworked the landscape of New England. Moraine and other ice-contact and outwash features left old land surfaces covered in sand and rock. Glacial meltwater deeply scoured and rapidly filled other locations. Ice and sediment dams produced extensive proglacial lakes throughout the region, such as Lake Hitchcock that filled the Connecticut River Valley. When these lakes drained, extensive sandy plains and wetland systems evolved in their places.

Vegetative colonization occurred fairly rapidly depending on local soils, hydrologic and topographic constraints. Colder and drier conditions prevailed 12,000 years ago. Overall, the pattern was one of warm summers and severe winters in a relatively arid climate (Jones 1998).

The sequence of sub-regional plant succession at around 11,000 years ago was diverse, reflecting local temperature gradients, soil conditions, precipitation, topography, and changes associated with fires, floods and storm patterns. Human adaptations to the resources of a given environment occurred at a local rather than regional level. By this time, a true forest canopy blanketed most of southern New York and New England. This forest was unlike any currently existing in North America, as it contained an admixture of warm-weather deciduous tree species within an otherwise boreal forest. This situation was particularly evident along the coast in southern New England where a pine-oak forest had established itself (Jones 1998).

An important climactic shift occurred abruptly in the Northeast, associated with the Younger Dryas event. However, the precise timing of this event recently has been called into question. For decades, researchers have worked under the understanding that the Younger Dryas lasted from approximately 11,000–10,000 B.P. (e.g., Fairbanks 1989:639; Mayewski and Bender 1995; Taylor et al. 1993). However, recent research indicates a likely range of 12,900–11,700 B.P. (e.g., Bard et al. 2010; Carlson 2010:383; Meltzer and Holliday 2010:8). The Younger Dryas event resulted in a shift to cooler, moister conditions and stormier weather in much of the region, and its end appears to have been very abrupt, with climate patterns shifting to one of increased warming over as little as three years. The onset of the Holocene is marked by an interval of rapid global climatic warming and reduction in the ice sheets. The transition from the Younger Dryas to the Holocene represents a period of rapid vegetation change as plant communities shifted their ranges in response to milder growing conditions. The rapidity with which the plant community changed indicates expansion of individual species occurred from scattered refugia where species such as white pine, oak, and hemlock had maintained relict populations throughout the Younger Dryas event. Estimated temperatures in southern New England ca. 9000 B.P. were comparable to those of today. In southern New England, white pine established itself as the dominant species. Pine forests were mixed with significant populations of oak and some birch at this time, while spruce was all but gone. Generally speaking, vegetation change between 10,000–6000 B.P. was more gradual and predictable than in the previous millennia (Jones 1998).

The distribution of late Pleistocene fauna in the Northeast is poorly recorded. Southern New England's coastal pine-oak forest probably supported most of the boreal forest animals and some of the temperate forest animals such as mastodon, stag-moose, woodland muskox, giant ground

sloth, caribou, elk, moose, giant beaver, long-nosed peccary, flat-headed peccary, white-tailed deer, flying squirrel, snow-shoe hare, beaver, muskrat, red squirrel, porcupine, woodchuck, otter, fisher, long-tailed weasel, raccoon, gray squirrel, striped skunk, and others. Long Island Sound and Narragansett Bay must have supported rich marine resources as well. Sea level change was less dramatic and rapid along the southern New England coastline than it was to the north. This meant that more productive estuarine habitats could form behind barrier beaches and along protected stretches of the coastline (Jones 1998).

Early Holocene faunal communities in the Northeast are somewhat better understood than those of the terminal Pleistocene. Unfortunately, it is difficult to separate out which animal types belong to the early, middle, or late Holocene. Estuarine habitats appear to have been established along protected shorelines in southern New England during the early Holocene (Gayes and Bokuniewicz 1991). Such settings would have supported an abundance of shellfish, as well as sea mammals, which fed upon them. The early Holocene forests of southern New England would have contained a limited diversity of large game mammals, but an abundance of small game mammals. Between 10,000–6000 B.P., increasing numbers of oak, especially in southern New England, provided an important seasonal food resource for humans as well as animals, such as white-tailed deer, turkey, and bear. Archaeological evidence suggests that anadromous fish species established themselves in the Northeast by this time as well. Species such as shad and salmon would have provided rich, seasonally predictable food resources to humans in southern New England at this time (Jones 1998).

4.2. RELATIVE SEA LEVEL CHANGES

The retreat, thinning, breakup, and final disappearance of the LIS from southern New England by about 14,000 B.P. did not mark an end to the ice-driven morphological alterations of the southern New England land-surface or the adjacent and exposed continental shelf within the SNE-GB study area (Uchupi et al. 1996). Worldwide melting of the continental ice sheets led to the return of water to the ocean basins and a concomitant rise in global sea level; however, the sea level curves and the complex interplay between isostatic and eustatic forces was markedly different north and south of Cape Cod.

Although it is difficult, if not impossible, to construct a model of global sea level rise, because of local neotectonism, a sea level rise curve from Barbados has been identified by Uchupi et al. (1996) as a close approximation of the response of sea level to Wisconsin glacial decay. The net rate of sea level rise varied locally as differences in the landscape's materials, morphology, and degree of crustal depression affected the interplay between isostatic and eustatic conditions. Local rates of sea level rise are determined through radiocarbon dating of salt-marsh peat deposits, which are considered accurate indicators of relative sea level (Oldale 1992; Redfield and Rubin 1962). The general trend of rapid sea level rise during this period, however, did not follow a smooth curve, but instead fluctuated and was punctuated by episodes of still-stand and negative sea level oscillations during times of climatic cooling and glacial advance (Rampino and Sanders 1980). At the glacial maximum, sea level was about 100 m below its present level. From this point it rose at a rate of about 11 m per 1,000 years as the eustatic increase in sea level outpaced the generally slower isostatic rebound of the Earth's crust, formerly depressed by the weight of glacial loading. By 12,000 B.P., sea level was approximately 70 m below present sea level, and was at 40 m below present by ca. 10,000 B.P.,

20 m below present by ca. 8000 B.P., and about 10 m below present by 6000 B.P. (Oldale 1992). After about 6000 B.P., the net rate of sea level rise began to slow significantly and gradually approached its present rate. Sea level approached its present level at about 1,000 years ago, and continues to rise at around a 2–3 mm per year (Uchupi et al. 1996:23).

Glacio-isostatic adjustment in the Cape Cod region, however, complicates the local relative sea level rise history of southern New England, so global isostatic curves are of limited use there. Curves developed for New England depart significantly from the Barbados curve. As a result of crustal depression by glacial loading, relative sea level in northeastern Massachusetts was about 30 m higher than its present level at about 14,000 B.P. This high-level stand, documented by emerged glaciomarine sediments, raised paleoshorelines and ice-contact deltas. The waters south of Cape Cod were not inundated during the marine transgression, as isostatic rise in the peripheral bulge resulting from glacial unloading in adjacent areas exceeded the rate of eustatic rise in sea level prior to about 16,000 B.P.

The high-level stand north of the Cape was short-lived, as the crust rebounded rapidly when its glacial ice load was removed. As the crust rose, sea level dropped and by 12,000 B.P., reached a post-glacial low-stand -43 m below present sea level off the coast of northeastern Massachusetts within the southwestern Gulf of Maine. Features associated with this sea-level regression include the paleodelta off the Merrimack River, a submerged barrier beach and lagoon on Jeffrey's Ledge, the seaward limit of shelf valleys off of New Hampshire, submerged terraces off of Maine, and a regressive unconformity in Penobscot Bay, Maine (Uchupi et al. 1996). A slowing of crustal uplift, coupled with an increase in eustatic sea level rise shortly after 12,000 B.P., caused sea level to begin rising again along the coast of northeastern Massachusetts and throughout the rest of southern New England. Between ca. 9500 and 6000 B.P., Stellwagen Bank, most of the Billingsgate Shoal moraine, Cape Cod Bay, Nantucket Shoals, and Nantucket Sound were all drowned (Uchupi et al. 1996).

4.3. MARINE TRANSGRESSION AND SITE PRESERVATION

Generally speaking, episodes of marine transgression are essentially periods of erosion, a destructive process that creates less than ideal depositional sequences from an archaeological perspective (Belknap and Kraft 1985; Goff et al. 2005; Kraft 1971, 1985; Kraft et al. 1983, 1987). Marine transgression proceeds in one of two ways: by —shoreface” retreat, when the coastline slowly regresses inland, or by —stepwise” retreat, when in-place drowning of coastal features occurs (Waters 1992).

Shore-face retreat describes the erosion of previously deposited sediments by wave and current processes as the shoreline transgresses and is the dominant inundation regime during the marine transgression process (Waters 1992). As the glaciers melted and sea level rose, beach-face and shore-face erosional zones, offshore of the present southern New England coastline within the SNE-GB study area, sequentially passed across the subaerially exposed portions of the continental shelf outwash plain. Older sediments that had been deposited in coastal and terrestrial environments inland of the shoreline were reworked, first by the swash and backwash processes upon the beach face and then by the waves and currents associated with the upper shore-face breaker and surf zones. The erosion associated with the continuous transgression of the sea reworked these deposits into a thin unconformable geological unit of transgressive lag (i.e.,

gravel and coarse sand deposits) forming the top of a time-transgressive geological unit known as a “marine unconformity” (i.e., the surface defined by the top of the buried paleosol and the base of the overlying marine deposit). Reworked terrestrial and coastal sediments are referred to as “palimpsest sediments” (Swift et al. 1971), and the erosional surface, marked by the depth of the maximum disturbance by transgression, is called the “ravinement” surface. This surface often shows up quite clearly in sub-bottom profiler data and can be a useful indicator for the presence of relict paleolandforms (Belknap and Kraft 1985; Kraft 1971; Waters 1992). Shore-face retreat would have probably been the prevailing marine transgressive regime in the unprotected portions of paleoshorelines within the SNE-GB study area, especially during still-stand episodes and after ca. 6000 B.P., when the regional rate of sea level rise appears to have slowed considerably.

Alternatively, and to a lesser extent, marine transgression also occurs by the process of stepwise retreat, which is the sudden inundation or in-place drowning of coastal landforms and sediments (Rampino and Sanders 1980; Sanders and Kumar 1975a, 1975b). Stepwise retreat most commonly occurs at times and in areas of rapidly rising sea level, where the coast is quickly subsiding and the gradient of the transgressed surface is shallow. In this case, instead of the waves and currents of the shore-face and beach face sequentially reworking older sediments during transgression, the breaker and surf zones jump from the active shoreline to a point farther inland, submerging the older coastal landforms and sediments in an area seaward of the more destructive breaker and surf zones. The surf and breaker zones then stabilize and develop a new shoreline farther inland. Instances of in-place drowning during stepwise retreat, preserving forested uplands, barrier-island and lagoonal sequences, and other relict shoreline features, have been documented in a variety of places along the Atlantic coast (Rampino and Sanders 1980; Robinson et al. 2004; Sanders and Kumar 1975a, 1975b).

Evidence of intact paleosol deposits from unprotected waters in excess of 1–2 miles from shore in the Northeast has thus far proven exceedingly rare (John King, personal communication 2004). One documented instance of a contextually intact, stratified paleosol deposit has been identified in a high-energy environment 8–10 miles offshore in Nantucket Sound using existing environmental data, sub-bottom profiles, and vibracoring (Robinson et al. 2004). Sub-bottom profiler reflectors recorded in this area were tested with coring and found to be produced by a distinct layer of intact paleosols (i.e., a thin ravinement horizon consisting of marine sediments with shell hash intermixed with a partially reworked organic-rich A0-horizon of duff, overlying organic A-horizon soils, oxidized B-horizon soils, and C-horizon sub-soils) buried under approximately 2 m of reworking marine sediments.

Subsequent macro-fossil analyses of cores from several different loci within Nantucket Sound identified several terrestrial ecozones (an upland deciduous forest floor, a shallow fresh or brackish water marsh, and a shallow freshwater pond or swamp). Organic material (i.e., a large piece of birch wood and a plant seed) contained in two of these cores was AMS-radiocarbon dated by the Woods Hole Oceanographic Institution to approximately 4500 B.P. and 10,100 B.P. (John King, personal communication 2004). The results of the coring and dating corresponded well with the modeled general locations of these ecozones at these approximate times based on currently available local sea level rise models that had been applied to existing bathymetry. Utilizing this method of paleosol presence/absence detection has proven effective during other investigations conducted throughout the Northeast (Herbster et al. 2004; Leveillee et al. 2002; PAL 2002, 2003a, 2003b, 2004, 2005a, 2005b, 2005c; Robinson and Ford 2003; Robinson and

Waller 2002; Robinson et al. 2004, 2005). Similar approaches have also been applied by Fehr et al. (1996), Maymon et al. (2000), Klein et al. (1986), and Riess et al. (2003).

Although shore-face retreat is the dominant transgressive regime, it is anticipated that there were numerous isolated occurrences of stepwise retreat also within locally favorable conditions throughout much of the SNE-GB study area.

4.4. ARCHAEOLOGICAL SENSITIVITY AND PRESERVATION POTENTIAL

A review of the available literature revealed that although there is an extensive inventory of ancient Native American archaeological sites spanning the entire pre-contact period on land in Connecticut, Massachusetts, and Rhode Island, no pre-contact period archaeological deposits have been identified to date within federally-controlled waters in the SNE-GB area. However, all of Nantucket Sound, which includes the portion of the SNE-GB that is encompassed by the Sound, has been determined by the Keeper of the National Register of Historic Places to be eligible for inclusion in the National Register under all four criteria for evaluation and as a traditional cultural property that has:

...yielded and has the potential to yield important information about the Native American exploration and settlement of Cape Cod and the Islands, and as an integral, contributing feature of a larger, culturally significant landscape treasured by the Wampanoag tribes and inseparably associated with their history and traditional cultural practices and beliefs (Advisory Council on Historic Preservation [ACHP] 2010).

The Keeper also acknowledged the importance of the Nantucket Sound seabed as “former aboriginal lands of the Wampanoags and the potential location for intact archaeological sites” (ACHP 2010), based on the identification of deposits of archaeologically sensitive organic sediments deposited in a terrestrial environment discovered in what is today a high energy marine environment 8–11 miles offshore (Robinson et al. 2004).

The three buried terrestrial deposits were identified by a marine archaeological reconnaissance survey conducted for the Cape Wind Offshore Energy project (Cape Wind). These deposits were interpreted to be an intact forest floor and quiet shallow aquatic areas (e.g., a freshwater pond, headwaters of an estuary, or a relatively close coastal pond), with AMS radiocarbon dates for the different samples ranging from 5490–10,100 B.P. (Robinson et al. 2004). The identification of inundated terrestrial sediments, described by the Massachusetts State Historic Preservation Officer (SHPO) as a “major scientific discovery,” was significant as the first recorded instance in southern New England of contextually intact paleosols systematically located by archaeologists in a high energy marine environment so far offshore (Massachusetts SHPO 2009).

Equally important was the fact that the inundated terrestrial deposits were identified through a phased, systematic and scientific archaeological investigative approach. This approach involved conducting an archaeological sensitivity assessment followed by a marine remote sensing reconnaissance survey and geotechnical sampling program. The general area where the paleosols were found was identified by Robinson et al. (2004) as archaeologically sensitive and

likely to contain intact inundated landforms during their 2003 archaeological sensitivity assessment of the Cape Wind project area. The specific areas containing paleosols were identified through a systematic survey process that involved using sub-bottom profiler data collected during the marine archaeological reconnaissance survey to identify buried acoustic reflectors with potential to represent relict terrestrial landforms. A select number of these reflectors were then chosen for “ground-truthing” via a program of geotechnical sampling (i.e., vibracoring) to determine whether the source of the reflector was a stratified relict landform with sensitivity for containing contextually intact ancient Native American archaeological deposits. The implications of the discovery of intact buried paleosols representing different elements of a partially preserved terrestrial paleolandscape are that:

1. The locations of such deposits are predictable and may be identified fairly easily and at a comparatively low cost within a cultural resource management context (by combining the archaeological data needs with those of the project engineers) using existing technologies and long-available marine archaeological survey techniques;
2. Intact elements of the archaeologically sensitive paleolandscape did survive the early Holocene marine transgression on a very localized level and can exist in high-energy marine environments a significant distance offshore; and
3. Study area-specific background research and geophysical survey and geotechnical testing are required to identify archaeologically sensitive submerged paleosols—broad sensitivity statements about large areas of sea floor absent of locally collected geophysical and geotechnical data (except for characterizing areas of the sea floor that were once exposed as having sensitivity and those that never were exposed as having low sensitivity) is an unadvisable management strategy.

Robinson et al.’s (2004) efforts to identify archaeologically sensitive elements of the submerged paleolandscape were comparatively unique. Up until the last 10 years, significant efforts to identify submerged paleosols and ancient Native American archaeological deposits were not a regular element of compliance-related marine archaeological investigations. As a result, the absence of any identified sites within the SNE-GB study area must be considered more a function of the negligible amount of underwater archaeological research that has been conducted thus far in the region to identify pre-contact period submerged sites than a reliable indicator of the potential for such sites to exist within the SNE-GB study area.

Numerous predictive models have been developed to assess archaeological sensitivity and assist in locating pre-contact archaeological deposits on shore with great success. However, it is not clear that such terrestrial models would logically be equally applicable to the offshore environment. While it is easy to assume that existing bathymetry of the seafloor is a direct correlate to the topography onshore, it is unlikely for such to be the case. Instead, bathymetry should only be considered a vague, highly disturbed and reworked shadow of the paleolandscape’s formerly exposed geomorphology, and survey efforts should focus on identifying the intact relict elements of the pre-inundation paleolandscape that are preserved buried beneath the overlying protective layer of marine sediments. Marine archaeological surveys in a wide variety of offshore environments throughout southern New England in the past

10 years have repeatedly shown that the surface of nearly all of the formerly exposed paleolandscapes have been either disturbed significantly or removed altogether and reworked by the erosive forces associated with the marine transgression and modern wave and tidal current regimes. These surveys have also shown that the preservation of intact paleolandsurfaces appears to be an exceedingly rare occurrence, as the discoveries of paleosols within the Cape Wind project area is the only example recorded to date of such deposits preserved so far offshore. When paleosols are preserved, they are preserved on a very localized level as a result of a unique combination of environmental circumstances that protected them from destruction.

Submerged paleolandforms potentially containing archaeological deposits found in the originally proposed offshore Cape Wind project area were found in areas that were relatively low on the more protected eastern flank of the Horseshoe Shoal. This is an area that was rapidly inundated and buried, and consequently survived the erosional effects of marine transgression and subsequent modern impacts from waves, tidal currents, and human activities. Generally speaking, the prerequisite for preservation of inundated sites is burial in terrestrial or low-energy marine sediments prior to the transgression of the ocean's rising waters (Waters 1992). In these cases, sites will be preserved if the sediments they are in remain below the depth of shore-face erosion that occurs during and after the marine transgression process, and have not undergone substantial sediment reworking following inundation.

Based on published rates of sea level rise above and below the Cape, the study area could have been available for human occupation from ca. 12,000–10,000 B.P. (i.e., during the Paleoindian and Archaic cultural periods). Progressively smaller portions of the area would have been available thereafter up until about 1000 B.P., when local sea level had reached a point within approximately 1 m of its current level. Prior marine archaeological survey coverage is lacking within the study area; however, the relatively protected, shallow nature of this area suggests that it is likely to possess conditions that would favor preservation of intact buried paleosols.

Thus, the archaeological sensitivity of the SNE-GB study area can be characterized as one of three categories representing each area's potential for containing pre-contact period archaeological deposits: No Sensitivity; Low Sensitivity; or High Sensitivity (Figure 4.2).

The area designated as having No Sensitivity lies below the projected -107 m sea level lowstand corresponding with the glacial maximum of ca. 20,000–18,000 B.P. This area encompasses an estimated 11,857 square miles of sea floor or 46.7 percent of the overall SNE-GB study area. It is presumed to have always been under water and was never subaerially exposed in the history of a human presence in the Northeast; hence, it has no potential for containing ancient Native American habitation sites.

The Low Sensitivity area lies between the -107 m and -70 m sea levels, the latter of which corresponds to ca. 12,000 B.P. and the time around which archaeological evidence indicates the first human colonists began arriving in the region. While it is unlikely that this portion of the study area contains any archaeological sites, it cannot be ruled out entirely. The Low Sensitivity area encompasses an estimated 3,214 square miles of sea floor or 12.7 percent of the overall SNE-GB study area.

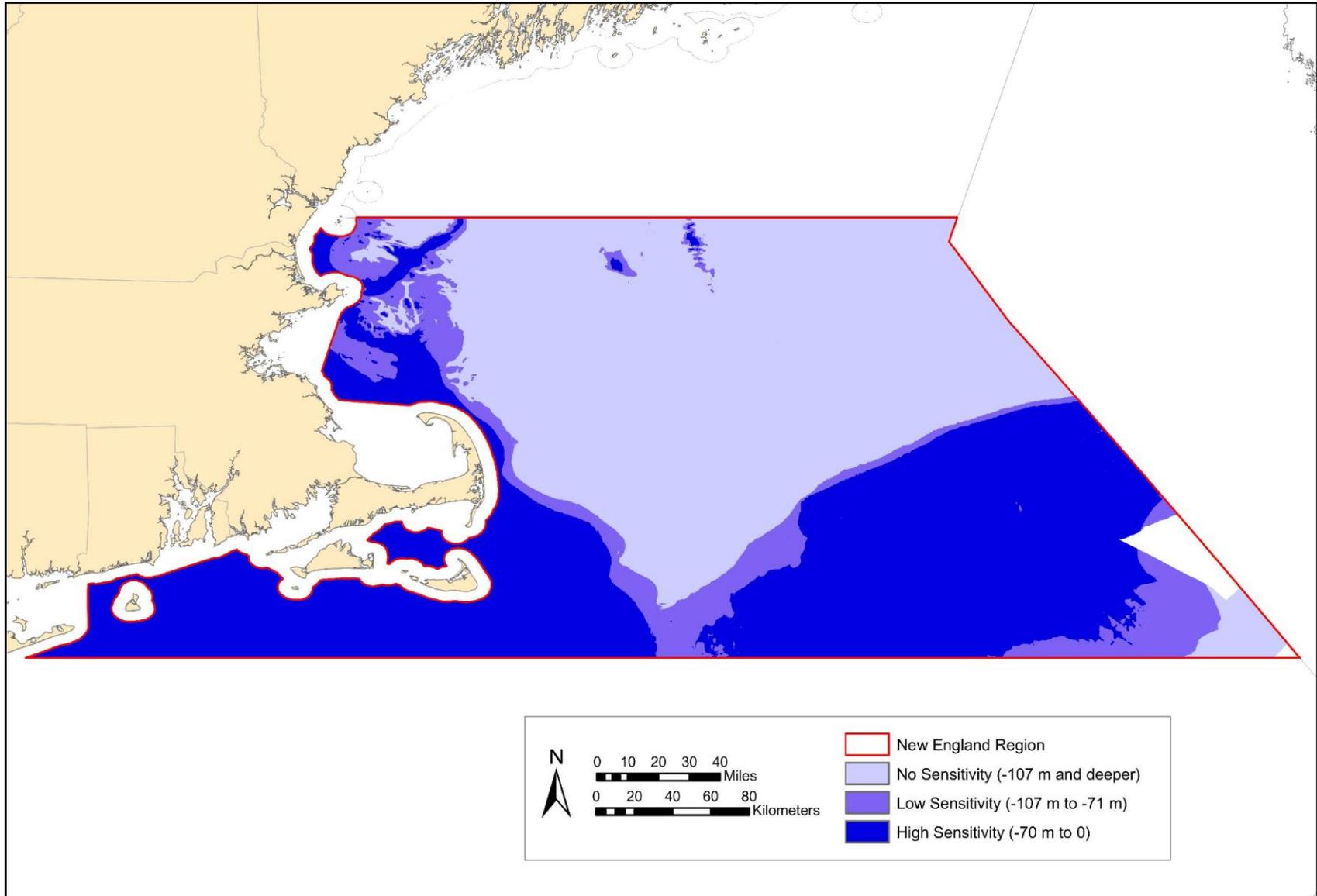


Figure 4.2. Archaeological Sensitivity map for the Southern New England–Georges Bank study region.

The area designated as having High Sensitivity includes the portion of the SNE-GB study area that extends between the -70-m sea level of ca. 12,000 B.P. and the 3-mile nearshore limit of federal waters and the SNE-GB study area. This 3-mile line also corresponds closely with sea level at around 6000 B.P. Thus, it is within this portion of the SNE-GB study area that there was exposed land available for habitation ca. 12,000–6000 B.P. by ancient Native Americans associated with the Paleoindian, Early Archaic, and the early part of the Middle Archaic periods. The High Sensitivity area encompasses an estimated 10,316 square miles of sea floor or 40.6 percent of the overall SNE-GB study area.

Archaeological research on land has repeatedly demonstrated that ancient native peoples in the Northeast and elsewhere sought the most productive ecological zones within their cultural landscapes, especially in those areas that offered diverse resources consistently on either seasonal or year-round bases. Some of the richest habitats of diverse flora, fish, and wildlife are found near the junction of land and water, both fresh and salt. Riparian corridors consisting of rivers, streams, and estuaries, their beds, banks, and floodplains, along with the soils, plants, and animals that exist there are among the most productive biological systems in the world. Areas where such elements of the formerly exposed paleolandscape were preserved intact would be most likely to contain archaeological deposits.

Archaeological site types that could be present within the High Sensitivity area would include the full range of site types described in Chapter 2 above, as well as Paleoindian and Early Archaic coastal site types that have yet to be encountered and identified and have no corollary in the present terrestrial archaeological record (e.g., large, long-term coastal base camps, medium and small special-purpose activity areas, coastal fishing sites, transportation corridors, semi-permanent habitations, and burial sites distributed along formerly exposed, inundated relict river margins, floodplains, and terraces).

Further delineation of the High Sensitivity area's archaeological potential is not possible without conducting area-specific geophysical survey and geotechnical sampling directed at locating archaeologically sensitive paleosols, given the presumed discontinuous and localized nature of their preservation throughout this offshore area (based on the experiences from the Cape Wind project-related discoveries in Nantucket Sound and other archaeological surveys conducted throughout southern New England waters).

5. NEW YORK AND NEW JERSEY

This chapter addresses the OCS off the coast of New York (principally Long Island) and New Jersey, which includes the curve in the shoreline in this region referred to as the New York Bight (Figure 5.1).

5.1. REGIONAL GEOLOGY

To understand where on the OCS archaeological sites might be preserved intact, it is necessary to understand the geomorphology of the region and the events of the Late Quaternary period that shaped the landscape now submerged offshore. Beyond the dramatic changes taking place at the end of the Pleistocene when the continental ice sheet was in retreat, it is also critical to understand subsequent processes in the Holocene during the course of marine transgression and afterward that affected the potential for site preservation. The Late Pleistocene was a time in which the landscape of the region surrounding the New York Bight was transformed by a variety of geological events and processes, the most important of which were associated with glacial retreat and subsequent sea level rise. The evolving landscape over the 12,000 or more years of human presence in the region has been reconstructed through studies of the current sea floor and dry land connected to it. A picture of the changing conditions characterizing the OCS in the New York Bight is presented in this section.

Around 20,000 B.P., when the Wisconsin glacier had reached its maximum southern extent, sea level was estimated to have been approximately 120 m lower than present, and the vast majority of the OCS was subaerial (Dillon and Oldale 1978; Wright et al. 2009). It was at this time that terminal and recessional moraine formations were created from poorly and well-sorted glacial till (i.e., boulders, rocks, gravel, sand, silt, and clay) on Long Island and contiguous areas.

The ice front in the vicinity of Long Island created terminal and recessional moraines that in turn created other major features in the geography of the region. The two major moraines include the Ronkonkoma, which extends along the length of Long Island, and the northeast trending Harbor Hill Moraine, which extends offshore from Long Island at Orient Point and continues past Plum Island and Fishers Island to the south coast of Connecticut–Rhode Island near Point Judith (Uchupi et al. 2001:133). The morainal deposits along these features consist of soil, sediments, decomposed rock, and fragmentary bedrock scoured over the landscape as the ice flowed southward across the region. Sloping away from the ridges of glacial till was an extensive outwash plain of finer materials carried away from the ice sheet in meltwater flows. The sediment flowing away from the ice front became size sorted with distance, resulting in a decrease in elevation across the plain, seaward from the moraine (Oldale 2001a, 2001b).

Immediately south of the ice front, the massive weight of the glacier compressed the land surface, creating a foredeep, or elongated depression, thought to have had relief of 200–300 m depth and beyond that a peripheral bulge with relief of about 70 m (Peltier 1982; Uchupi et al. 2001:127). The seaward edge of the foredeep south of Long Island probably was located in the vicinity of the present 40–50 m contours. Dillon and Oldale (1978) inferred that the peripheral bulge covered the rest of the shelf ending southwestward of an inflection zone trending northwestward to the coast from the shelf's edge. Despite model predictions concerning the

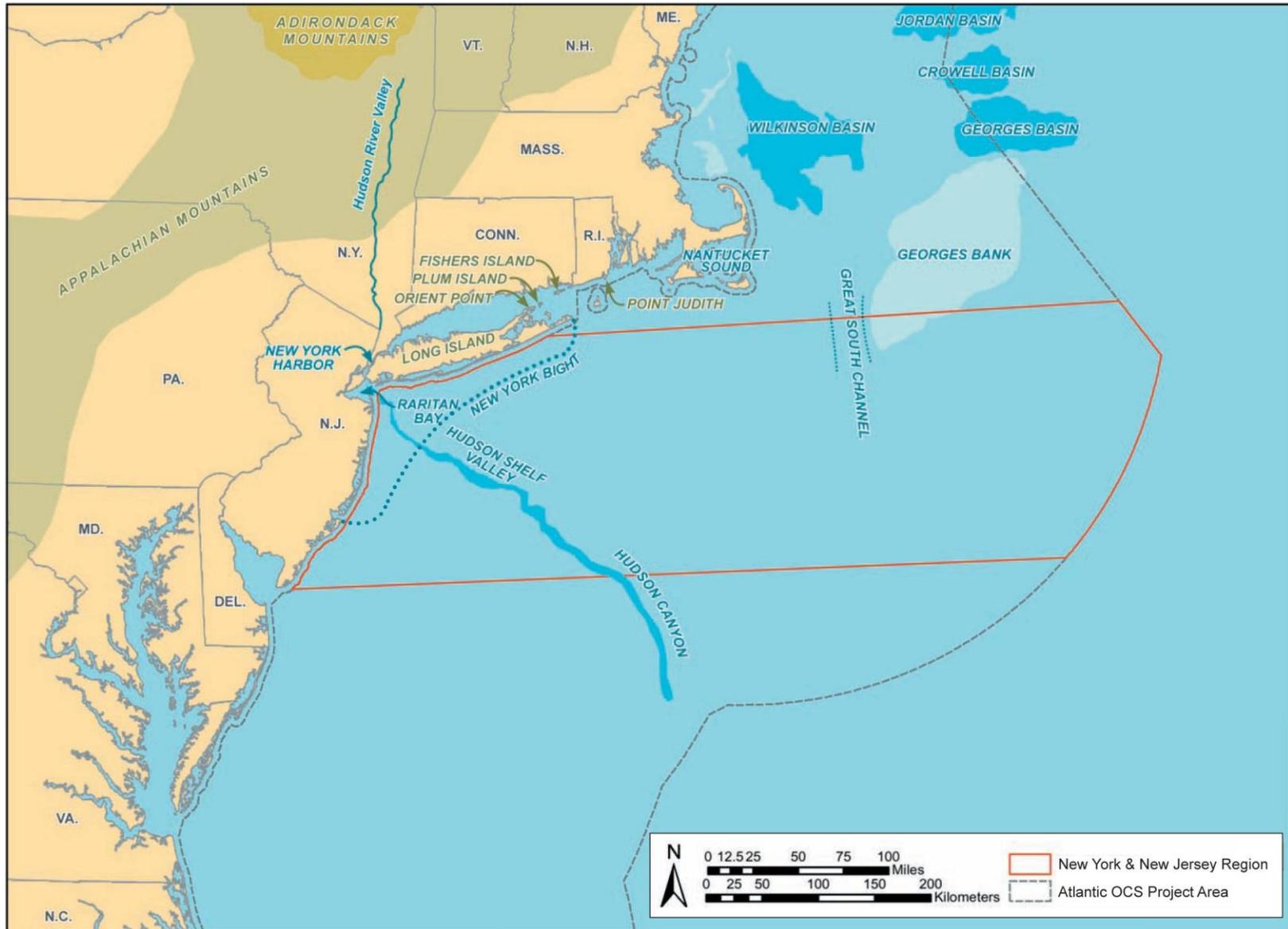


Figure 5.1. New York–New Jersey study region.

position and relief of the peripheral bulge and foredeep (Peltier 1982), it is difficult to define its location based on the drainage patterns observed across the shelf (Uchupi et al. 2001:127). Quantifying the relief of the foredeep and peripheral bulge and the character of rebound during the course of marine transgression is not a straightforward matter. For example, comparison of a peat off Long Island to the Fairbanks (1989) sea-level curve indicates that the former foredeep has only rebounded isostatically 27 m during the last 10,000 years such that the foredeep may not have been as deep as Peltier (1982) suggested or else much of the rebound occurred before the marine invasion (Uchupi et al. 2001:127).

The foredeep and peripheral bulge were not the only topographic features occupying the exposed continental shelf of the New York Bight. This land area was also dissected with drainages that have been observed on the current seafloor. The preservation of the drainage patterns after transgression is not completely understood, and may be attributed to sedimentation rates, rapid submergence (e.g., from forebulge collapse), stream capture, headland protection, and/or bedrock controlling stream channels. The most prominent drainage channel preserved in the New York continental shelf is the Hudson Shelf Valley (known as the Hudson Canyon), which extends 130 km southeast from the current Hudson estuary to the outer continental shelf, and is incised up to 100 m below the adjacent shelf surface. The central portion of the Hudson Shelf Valley is deeper than the valley head or river mouth, as a result of being incised into the glacial forebulge that later subsided. The mouth of the Hudson Shelf Valley is 9.5 km wide and is adjacent to the Tiger Scarp on the southwest, a landform displaying 18 km of relief which was the shoreline at roughly 10,000 B.P., and the Fortune Scarp to the east, a contemporary feature that displays 10 m of relief (Freeland et al. 1981:399–402). Various buried channels have been identified through seismic data, reflecting smaller drainages that have filled completely with Holocene sediment (Freeland et al. 1981:406–407). More recent work has seen channels on the New Jersey shelf that are identifiable, but affected by erosion (Goff et al. 2005:288). It is important to note that the configuration of shelf valleys observed today represent the product of estuary mouth scour as transgression moved the river mouths landward, rather than the morphology of the valley prior to transgression (Freeland et al. 1981:422).

Because the OCS off New Jersey is a sediment starved environment, the seafloor bedforms and shallow subsurface sediments preserve the effects of Pleistocene–Holocene regression and transgression, although sand ridges and swales oriented northeast–southwest have subsequently been formed through erosion due to bottom flow and tidal currents. Up to 10 m of sediment have been removed from the transgressive sand sheet in some areas, and ridges in the OCS have been winnowed, with smaller grains removed to leave consolidated sand ridges that have become resistant to further erosion (Duncan et al. 2000; Goff et al. 1999; Goff et al. 2005:291).

Much of the New York Bight has been mapped using side scan radar (e.g., Lathrop et al. 2006; Schwab et al. 2000) and the Hudson Shelf Valley has been examined in detail (e.g., Butman et al. 2003). Some aspects of the Hudson Shelf Valley morphology reflect events in the Late Pleistocene with far-reaching implications for the regional landscape and potential for site preservation. The Hudson Shelf Valley has rectilinear sides and is oriented north-south at its head, then northwest-southeast for its remaining length. The morphology of the valley (particularly near its southeastern outlet) reveals a braided channel or anastomosing channels and fluvial bars. Part of the valley floor resembles a straight channel with alternating bars and

sinuous thalweg and straight channel banks. At the mouth of the Hudson Shelf Valley is a delta-like feature whose surface is marked by a southwest trending distributary system draining in the direction of Hudson Apron on the OCS southwest of Hudson Canyon (Bloom 1998; Uchupi et al. 2001:119). The Hudson Apron is one of a number of lobes on the OCS at the outlets of paleochannels in the New York Bight as well as to the east off the coast of New England. The lobate shelf morphology along with the wavy terrain near the mouth of the Hudson Shelf Valley, the presence of coarse clasts on the mid-shelf and abundance of land mammal remains associated with them, have been interpreted as evidence of episodic massive flooding of the shelf by the draining of glacial lakes formed behind the Wisconsin terminal moraine and subsequent flashfloods after the lakes drained. Two major episodes of catastrophic draining occurred, one at 17,000–15,000 years ago creating the features in the shelf east of the Hudson Shelf Valley and the Hudson Apron, and another at 14,000–12,000 years ago creating the sediment lobes, including the mid-shelf wedge, on either side of the Hudson Shelf Valley (Uchupi et al. 2001:126–127).

After ca. 20,000 B.P., when the LGM reached its southernmost extent, the ice began melting back as the climate shifted into a cycle of global warming. Meltwater from the shrinking ice sheets was funneled into lakes and rivers that ultimately returned it to the world's ocean basins. Thus the maximum exposure of the continental shelf in the New York Bight was at ca. 20,000 B.P. and the Atlantic Ocean began reclaiming that land thereafter.

Runoff from the melting ice was trapped behind the region's terminal and recessional moraines creating an extensive geography of proglacial lakes in eastern New Jersey, New York, New England, and adjoining areas of Canada as the ice retreated (Figure 5.2). Seepage through the moraine allowed the formation of small channels through what was then the exposed shelf—channels that have been documented in mapping of the ocean floor. But more striking are aprons of sediment and rocks forming large wedges at the mouths of paleochannels, which derive from catastrophic floods, which took place over a 5,000 year period ending by 11,000 B.P. (Uchupi et al. 2001). Major flooding events are hypothesized as each glacial lake was drained when erosion weakened points along the moraine, glaciers calved off large icebergs that suddenly raised lake levels and created high-energy waves, and/or tectonic uplift to the north and subsidence to the south from ice unloading stressed the landform holding back the water. The sudden release of large volumes of water, debris, and sediment is responsible for moving rocks and sediment hundreds of miles across what was then the exposed shelf and creating episodes of extreme turbidity at the river mouths, such that large rocks were transported well off shore into what are now deep sea contexts. Additional splays along the paleochannels document subsequent flash floods that originated in the drained lake beds (Uchupi et al. 2001:139–140).

A number of glacial lakes existed in the region at points in the terminal Pleistocene (see Figure 5.2). In some cases, their geologic histories are connected. For example, Lake Passaic, which extended across the terminal moraine, was blocked at its southwest end by till that filled gaps at Mogy Hollow and Short Hills. As the ice retreated northward, the lake drained via the Short Hills gap in the Watchung Mountains and the Little Falls-Paterson outlet into the region of the future Lake Hackensack. Lake Hackensack breached its dam at Raritan Bay as a result of rapid isostatic uplift and drained onto the shelf. Lake Hudson occupied the valley south of the

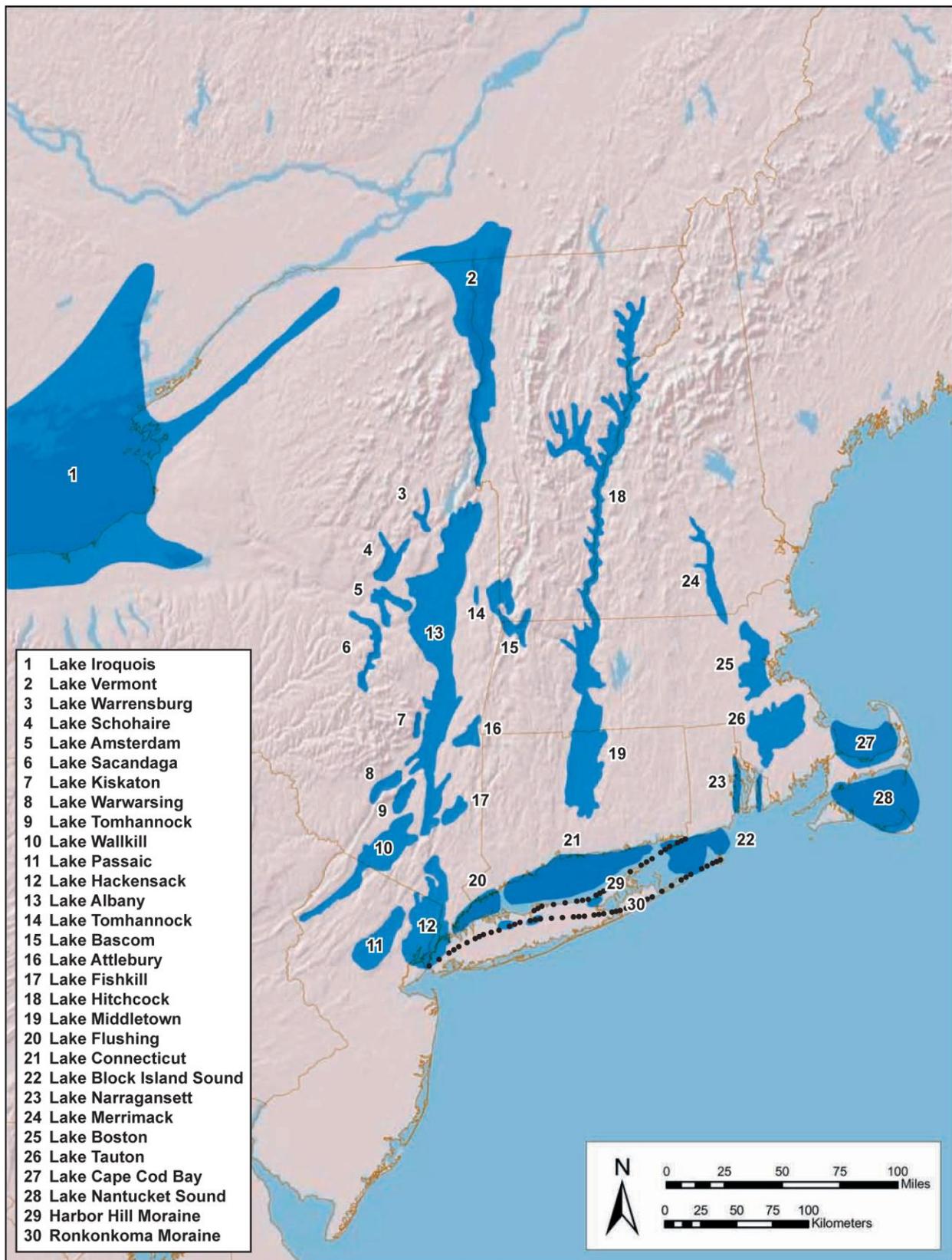


Figure 5.2. Glacial lakes in the region, ca. 18,000–12,000 B.P.

Hudson Highlands and was dammed by the terminal moraine at the Narrows. After Lake Hackensack drained, Hudson Lake overflowed onto the empty Lake Hackensack basin, eroded the exposed Hackensack lake clays and drained onto the shelf via the gap previously eroded through the terminal moraine in Raritan Bay. It was probably this drainage and the drainage of Lake Hackensack that were responsible for the erosion of the north-south trending ancestral Hudson River channel defined by the Reflector R unconformity on the New Jersey shelf (Dineen et al. 1988; Newman et al. 1969; Peet 1904; Reeds 1933; Uchupi et al. 2001:134–135). Varve counts suggest that Lake Hudson existed for approximately 3,000 years before it drained (Uchupi et al. 2001:134). The largest catastrophic flood events occurred as a result of the ice retreat north of the Adirondack Mountains, precipitating the draining of Lake Iroquois (in the Ontario basin) and Lakes Vermont and Albany through the Hudson Valley (Uchupi et al. 2001). After the draining of Lake Hudson, ca. 12,000 B.P., saltwater species are seen in dated deposits, reflecting the establishment of estuary settings far inland (Weiss 1974; Weiss et al. 1976).

On the east side of the New York Bight, a number of features on the shelf derive from the —SoundRiver,” which drained Late Wisconsin glacial meltwaters impounded in three lakes: Lake Flushing on the west end of Long Island Sound, Lake Connecticut which was separated from Lake Flushing by a north-south moraine, and Lake Block Island Sound. The Sound River created a series of deltas where it breached the moraine between Long Island and Block Island, and it ceased to flow once its channel was filled with morainal deposits (Frankel and Thomas 1966; Grim et al. 1970; Uchupi et al. 2001:128–134).

Before the draining of the proglacial lakes for a period several thousands of years, the shelf was sediment starved. It was a vast plain swept by strong winds, dissected by a few peripheral streams fed by waters draining through porous sections of the terminal moraine. It was only with the catastrophic drainage of meltwater lakes and subsequent erosion of the former lakebeds by flash floods that sediments in any significant amounts reached what is now the continental shelf. Initially the glacial outbursts probably exceeded the capacity of what few valleys were present on the shelf and the waters spread out over the shelf’s surface. With time, however, as the flows dissipated they became channeled and incised the sediments of the Hudson Shelf and Block Island valleys. These channels then served as passageways for later flows. Wetlands developed on what had been a stark landscape. The now submerged shelf bears the imprint of these catastrophic late Pleistocene events. Only the morphology of the inner shelf south of central Long Island and off New Jersey appear to be have been formed by nearshore processes associated with the last transgression (Uchupi et al. 2001:117).

In the case of the Hudson River, a series of more southerly channels once existed on the continental shelf off New Jersey (Carey et al. 2005). The migration of the Hudson channel is attributed to the glacier’s advancing peripheral bulge: as the ice sheet depressed the crust immediately in front of it and created a peripheral bulge to the south, the reduction in gradient of the Hudson may have allowed it to be captured by a smaller drainage system located within the foredeep. The new channel, the Hudson Shelf Valley, was further incised by the drainage of various glacial lakes by the Raritan and Hudson rivers from 17,000 to 14,000 years ago which deepened the valley, which was subsequently reworked by marine processes during transgression, becoming the modern Hudson Shelf Valley (Carey et al. 2005:169; Uchupi et al. 2001).

The Hudson River has been the principal source of sediment for the New Jersey portion of the OCS throughout the Pleistocene (Carey et al. 2005:157; Poag and Sevon 1989). Little sedimentation of the New Jersey portion of the OCS has taken place during the Holocene, as sediments are trapped in lagoons and estuaries (Carey et al. 2005:158; Clarke et al. 1983; Swift et al. 1972b). The low rates of sedimentation of the New York Bight during the Holocene have allowed Late Pleistocene features on the shelf to remain visible. The visibility of these features also suggests that much of the surface of the OCS was little modified by the late Pleistocene–early Holocene marine transgression, possibly because a rapid rise in sea level allowed for preservation of relict features (Uchupi et al. 2001:139). Such features have, however, been reworked by bottom flow, tidal currents, and other processes (Goff et al. 2005).

The sediment starved continental shelf extends approximately 85 miles to the shelf edge, at about the 150 m isobath, with a 0.068 gradient. The Hudson Apron, a seaward bulge marked by later iceberg scours, dominates the modern New Jersey shelf edge along with the heads of numerous submarine canyons (Ewing et al. 1963; Goff et al. 1999:322, 334; Pratson et al. 1994; Pratson and Haxby 1996). In general, storm-generated, southwestward-directed currents characterize the modern oceanographic regime on the middle and outer shelf (Butman et al. 1979; Duncan et al. 2000:398; Hopkins and Dieterle 1987).

Three seaward-stepping terraces, each bounded by a 10–15 m high scarp, have long been interpreted as relict Quaternary stillstand shores (Dillon and Oldale 1978; Emery and Uchupi 1972; Swift et al. 1980; Veatch and Smith 1939). The seaward edge of the mid-shelf wedge forms a prominent topographic feature on the New Jersey shelf: the Mid-Shelf Scarp or “shore”, sometimes referred to as the Tiger Scarp or Fortune “shore” (Dillon and Oldale 1978; Knebel et al. 1979; Milliman et al. 1990; Swift et al. 1980). Thought for decades to represent a fossil shoreface associated with a sea-level stillstand, high-resolution seismic data has since shown it to be depositional in origin (Duncan et al. 2000; Knebel et al. 1979; Milliman et al. 1990). Uchupi et al. (2001) have speculated that the mid-shelf wedge could be a subaerial deposit associated with massive outflows from breached glacial lakes along the Hudson Valley between approximately 19,000 and 12,000 years ago during glacial retreat. However, it has been found that the sediments forming the mid-shelf wedge date to 9,000–10,000 B.P. (based on eustatic curves) and derive from a transgressive marine environment after the lake collapses (Goff et al. 2005:284). The outer shelf seaward of the Franklin Shore contains deltaic sediments at the mouth of the Hudson River (Goff et al. 1999:322, 334).

5.2. RELATIVE SEA LEVEL CHANGES

Since the retreat of the late Pleistocene glaciers after approximately 20,000 B.P., the New York and New Jersey coastline has been progressively inundated. Although sea level continues to rise today, most shorelines attained their approximate modern positions by 1000 B.P. (Pirazzoli 1996:102).

There has been a significant amount of work researching sea level rise for the New York Bight. Three sea level curves for New York Harbor (summarized in Pirazzoli 1991:192–193) suggest that water levels were approximately 28 m lower 10,000 years ago, 22 m lower 8,000 years ago, from 12–17 m lower 6,000 years ago, 8 m lower 4,000 years ago, and 3 m lower 2,000 years ago. More recently, Donnelly (1998), Stanley et al. (2004), Miller et al. (2009), and Wright

et al. (2009) have examined various datasets to refine a sea level curve for the region. Miller et al. (2009) indicate that water levels may have been shallower at 10,000 B.P., suggesting a depth of 18 m lower than today, with a depth of 13 m at 6,000 B.P. and 10 m at 4,000 B.P. Wright et al. (2009), who focus on Late Pleistocene sea level rise, recalculated dates from Dillon and Oldale (1978) and Duncan et al. (2000) to conclude that sea level was 120 m below present at 21,000 B.P., and 78 m lower at 14,400 B.P.

Local sea level research typically derives from core samples near shore, and may have little relevance in reconstructing sea level rise during the late Pleistocene and early Holocene. Recently published research by McHugh et al. (2010), however, has helped to fill in this gap for the region. They examined 28 vibracores collected at 38–145 m depths on the New York–New Jersey continental shelf and radiocarbon dated the shells of mollusks that characteristically lived near the paleoshoreline and intertidal settings to document the timing and position of the paleoshoreline as eustatic rise progressed across the shelf. Their research, which takes into account the effects of glacio-isostatic forces, concludes that sea levels were at 120 m below present during the LGM, confirming previous studies such as Dillon and Oldale (1978).

Currently, it appears that Wright et al.'s (2009) assessment of sea level rise for the region is the most up-to-date and comprehensive, at least in terms of the Late Pleistocene and Early Holocene (encompassing the LGM and Paleoindian period), and has been used most recently by other researchers (e.g., McHugh et al. 2010; Nordfjord et al. 2009). For these earlier points in time, it is the sea level curve adopted in this report. For the more recent Holocene, Miller et al.'s (2009) research is used. In both cases, the sea level curves developed have taken into account the effects of eustasy as well as glacial isostasy (Miller et al. 2009:16; Wright et al. 2009:96).

5.3. MARINE TRANSGRESSION AND SITE PRESERVATION

Recent research in the New York Bight has provided a better understanding of the process of marine transgression. Examining data from high-resolution subbottom profiling and vibracores, McHugh et al. (2010) have observed that the advancing paleoshoreline reworked barrier and lagoon sediments during the period 15,000–11,000 B.P. Only a relic morphology of these features remains on the sea floor of the OCS from 120 to 60 m of present water depth, which they correlate with this time frame (McHugh et al. 2010:45), due to shoreface erosion and deposition of reworked sediments both seaward and as part of the transgressive sand sheets (Swift 1975; Swift et al. 1973). The remaining topography is characterized by ridges and swales. They also document evidence for a slowstand occurring between 12,000–11,000 B.P., which also disfavors preservation of what likely would have been the earliest potential prehistoric settlement period of the subaerial OCS (McHugh et al. 2010:44). Their research also documents dramatically decreasing sedimentation rates from ca. 11,000 B.P. to the present along the continental margin, with little sediment having been deposited on the outer shelf during the Holocene eustatic rise (McHugh et al. 2010:45).

The implications of these findings are that the seafloor in the region generally would have been exposed directly to the forces associated with transgression during most of the Holocene. These processes likely have erased most geologic evidence of subaerial exposure of the seafloor developed during the last recessional sea-level cycle (Nordfjord et al. 2009:235), and the seafloor in this area is constantly being eroded by bottom currents (Goff et al. 2005), although the sand

swales at depths greater than 50 m are considered to be generally inactive, subject to only some localized erosion (Goff et al. 1999). The geomorphology of the New York Bight holds out little potential for intact archaeological deposits, except in unique settings.

There are some localized exceptions to the model of an eroded seafloor across much of the New York Bight. Sanders and Kumar (1975a) argue that evidence from the Long Island Shelf points to in-place drowning around 7500 B.P. of a previous barrier approximately 7 km offshore from the current position of Fire Island. They observe sediment sequences and paleontological specimens from cores that reflect the presence of a lagoon through at least 4390 B.P. They interpret these findings as evidence that the barrier remained in place from the point when sea level was -24 m until it reached the top of the dunes at -16 m. During that time, the barrier island's dunes, thought to be 8–10 m tall like the contemporary Fire Island dunes, remained in place, while the lagoon on the landward side widened and deepened, effectively delaying the effects of sea level rise on the barrier. When sea level finally jumped the barrier, a new barrier was formed in the surf zone 2 km off the modern shoreline position. The barrier that formed 2 km from the current Fire Island subsequently migrated landward as sea level continued to rise, ultimately forming the contemporary barrier island. Previous views on transgression posited inevitable migration of barriers when sand supply could no longer keep pace with sea level rise; Sanders and Kumar (1975a:72), however, argue that the relationship between the rate of sea level rise and the rate of sediment supply determines whether the barrier retreats or is drowned in place. Bottom topography off the coast of Rhode Island suggests that barriers were drowned in place there as well (Dillon 1970; Garrison and McMaster 1966). Although the high ground of the submerged barrier island off Fire Island has been smoothed down with sediments deposited in the lagoon and other low spots both seaward and landward, some relict landforms may be preserved, in some cases buried beneath those very dune deposits that were displaced when sea level jumped the barrier island. The lee side of the dunes at a certain elevation may have been spared the effects of erosion, and instead could have been buried with a protective layer of sediment from the destruction of the dunes during transgression. Some of that sediment may have been winnowed away over time by bottom currents, storm events, and other forces, but artifacts could remain intact in roughly the locations where they were deposited.

Looking beyond localized examples of how transgression affected the OCS in the New York Bight, Nordfjord et al. (2009:241–242) have developed a model of the impacts of marine transgression for the region overall, tying it to the sea level curve developed by Wright et al. (2009). Their model is summarized as follows. During the LGM around 18,000 B.P., dendritic patterns of drainages incised the exposed shelf (Davies et al. 1992; Duncan et al. 2000; Nordfjord et al. 2005). During late lowstand/early transgression, shoreface retreat began and the base of the shoreface migrated landward (Swift 1968). Given their lower elevation, the drainages were flooded first, with the channels and valley floors scoured by wave action, creating the ravinement surface. No archaeological sites along these drainages would have survived transgression except where they had already been buried in deep sediments. As transgression proceeded, erosion of nearby portions of the exposed shelf resulted in sedimentation of the now submerged drainage channels (Duncan et al. 2000; Goff et al. 2005; Nordfjord et al. 2005, 2006; Nummedal and Swift 1987). When sea level had risen to around -70 m and all known fluvial networks on the mid- and outer shelf had been converted into estuaries, back-barrier tidal incisions were preserved either due to (1) pauses in shoreface retreat, which allowed formation of a substantive estuarine/back-barrier system that could not be completely destroyed by

subsequent transgressive ravinement; or (2) antecedent topography, for example preexisting depressions that allowed the shoreline to retreat rapidly once the barrier was breached so that the back-barrier morphology was preserved (Nordfjord et al. 2006). Due to remnant physiography of the latest Pleistocene part of the mid-shelf wedge, landward shoreface retreat slowed down during formation of the mid-shelf scarp around 11,400 B.P., when sea level was at approximately -50 m. This prolonged period of shoreface effects may have focused ravinement erosion along the seaward edge of the mid-shelf wedge, which in turn steepened its slope where that slope is coincident with the mid-shelf scarp. Ravinement of the Pleistocene mid-shelf wedge forms the foundation for the mid-shelf scarp. When sea level finally rose across the mid-shelf scarp, the Holocene part of the transgressive, onlapping mid-shelf wedge was constructed from coarse-grained sediment supplied by the Hudson River and/or eroded, winnowed shoreface sediments deposited in the near-shore zone. Powerful storm flows subsequently swept southward across this depositional lobe, which removed sediments from parts of the mid-shelf wedge and truncated its base (Swift and Freeland 1978). As the water column continued to deepen and the shoreline continued to recede, shelf sand ridges evolved (Swift and Thorne 1991; Goff et al. 1999; Snedden et al. 1999). Successive erosion of outer shelf sediments and modification of the seafloor has continued to take place through bottom current-driven erosion, perhaps undercutting surface armored seabeds (Goff et al. 2005) or differentially eroding preexisting topographic lows. The transgressive ravinement surface dominates New Jersey seafloor bathymetry today, but its morphology is complex and includes ridge and swale features which have been modified by deeper water erosion (Goff et al. 2005).

Nordfjord et al.'s (2009) scenario for the process and effects of marine transgression in the New York Bight has implications for the potential for archaeological site preservation. The process of transgression has worked to scour away landforms and any archaeological deposits they may have contained, but in some cases, it preserved particular features of the subaerial landscape. From cases of stepwise retreat such as that documented off the south shore of Long Island (Sanders and Kumar 1975a), and cases where existing topography allowed rapid filling and possible sedimentation of landforms that may have supported human habitation, it is clear that archaeological sites could be preserved in particular settings. Identifying such microlandforms on a shelf that has been subjected to bottom currents and other forces for thousands of years requires detailed coring studies.

5.4. ARCHAEOLOGICAL SENSITIVITY AND PRESERVATION POTENTIAL

As presented elsewhere in this study, the OCS can be divided into three general categories of site potential (Figure 5.3). One category is No Sensitivity, applied to areas 120 m and deeper that were subaerial prior to LGM, and are not expected to have supported human habitation. The next category is Low Sensitivity, mapped between the 120 and 70 m isobaths based on Wright et al.'s (2009) sea level curve, representing the exposed coastline from the LGM through the beginning of the Paleoindian period. The remaining High Sensitivity category represents areas exposed during the Paleoindian and later periods, from -70 m to more shallow areas. Within areas defined as Low or High Sensitivity, specific landforms will have potential for intact sites, while other areas can be ruled out due to the effects of transgression.

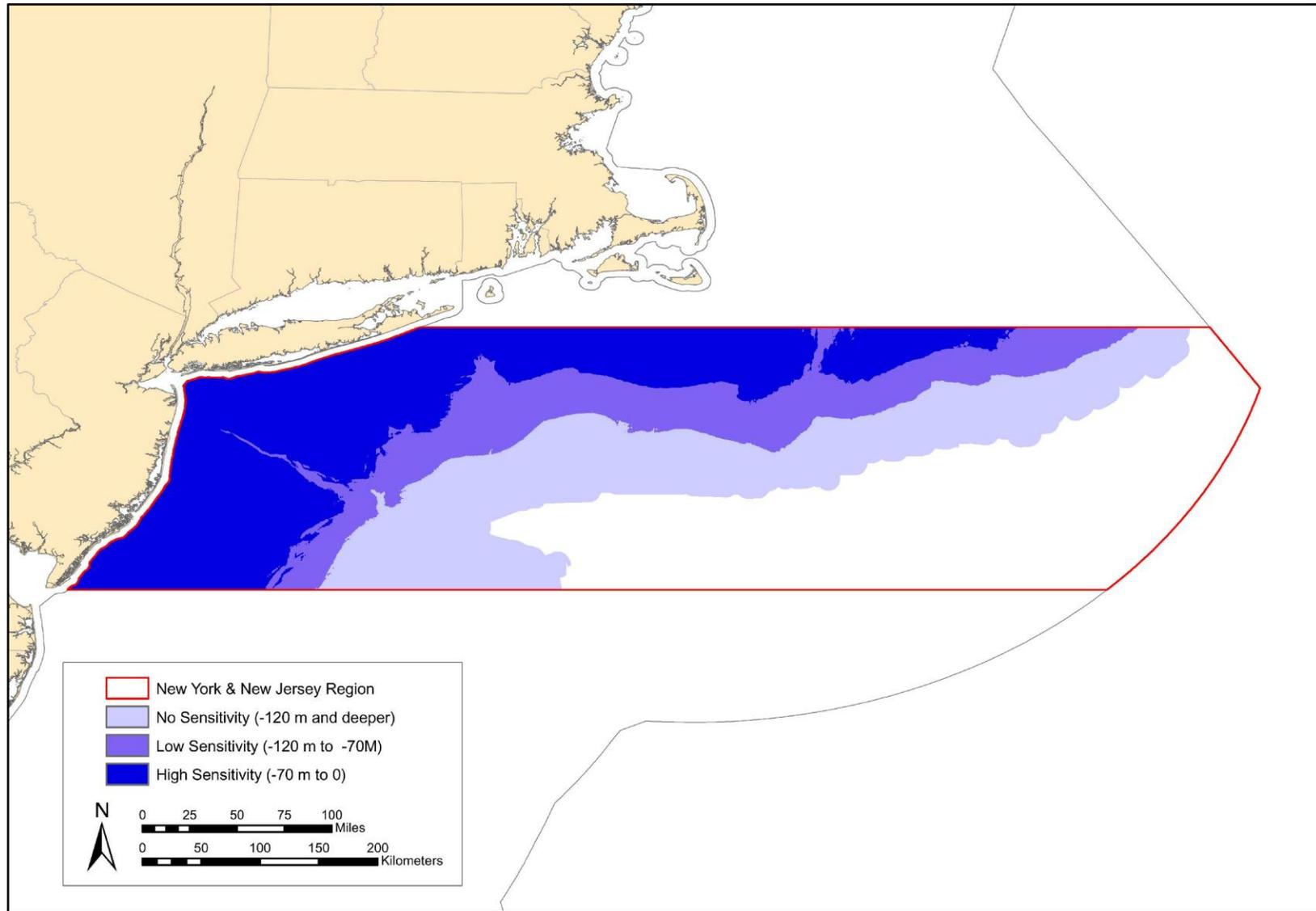


Figure 5.3. Archaeological Sensitivity map for the New York–New Jersey study region.

During the last three to five thousand years of the prehistoric era (and possibly earlier), the mouths of estuaries (including the Hudson River) were particularly attractive to hunter-gatherer-fishers, and many of the larger sites dating to the Late Holocene have been identified in these settings. Likewise, well-drained landforms overlooking the streams that emptied into the estuaries would also have been resource-rich, prime site settings. The question is whether such site settings on the OCS would have survived transgression such that any archaeological remains once present would remain intact.

Significant paleochannels of major streams which are now delineated as bathymetric features in sonar datasets and digital elevation models include the drowned Hudson River, the Raritan River (roughly west-east through New York Harbor into the New York Bight), a major channel running south across the Long Island Platform (originating between the east end of Long Island and Block Island), and numerous smaller streams. Among the landforms adjacent to the paleochannels with higher sensitivity are terraces and places where smaller streams join the larger channels. Similarly, irregularities along open paleoshorelines may have been more attractive to prehistoric hunter-gatherer groups than straight and broad coasts, because such irregular landforms could have offered better protection from the elements as well as potentially more dense and/or diverse resources such as wetland fauna and flora adjacent to fishing grounds (Perlman 1980). Such irregular coast features include narrow inlets, headlands, and stream mouths (Benjamin 2010; Fischer 1995), along with protected areas like backbays and lagoons. Unfortunately, it is difficult to identify particular small-scale landforms, some of which may be obscured by later sediments.

Based on Nordfjord et al.'s (2009) model, only specific site settings might have been preserved in the region. They include rapidly submerged features protected from subsequent erosion by initial sedimentation. Candidate landforms include portions of drainage valleys that were covered in sediment prior to transgression, the margins of sheltered tidal estuaries and coastal ponds far enough landward to avoid the brunt of coastal shoreface erosion, and the protected side of barrier islands that were inundated through stepwise shoreline retreat. Whereas research in Nantucket Sound has produced evidence of an intact paleosol (see Chapter 4 above), no such evidence has been found in the New York Bight region. However, a coring study for dredged material placement in the New York Bight concluded "that the potential for submerged archaeological sites is actually greater than previously recognized" based on samples that yielded sediments indicative of a paleoshoreline environment (LaPorta et al. 1999:26). However, the location of the paleoshoreline deposits on the continental shelf was determined to have been susceptible to erosion during sea level rise, such that the chance of encountering an intact prehistoric archaeological site was considered moderate rather than high (LaPorta et al. 1999:29).

Some localized settings would have been less affected by erosion, and should be prioritized for study. For example, the flood deposits along the paleochannels such as the Hudson Shelf Valley may very well seal archaeological deposits along river valleys dating after the period of glacial lake draining (see Uchupi et al. 2001). The deltas created at the mouths of the paleochannels from catastrophic flood events are probably not likely locations to find archaeological remains for a number of reasons, however. The low-lying areas at a river mouth would not have been a likely location for human settlement due to tidal inundation and restricted access to fresh water. Even if archaeological remains were present where the delta was subsequently formed, the high-energy flooding and turbidity from the water's entry into the

ocean would likely displace artifacts, and compromise any site integrity. Furthermore, the large boulders and rocks deposited during the catastrophic flooding would make identification and investigation of any archaeological site exceedingly difficult. However, locations upstream along paleochannels may have supported human habitation in what would have been floodplains and terraces overlooking riverine and estuary settings. Such sites would likely only be preserved after the catastrophic meltwater lake floods, which would have impacted any earlier sites present in their paths. These settings could very well be preserved beneath sediment accumulated in later flash floods, from estuarine muds deposited as marine transgression advanced upstream, gradually inundating the valley, and from subaerial deposition governed by currents perpendicular to the channel, which became a sediment trap (Freeland et al. 1981).

Because the seafloor has not been studied and mapped in sufficient detail to locate all the specific landforms that existed prior to transgression, it is not possible to precisely delineate potential site settings within high preservation potential. However, geophysical studies carried out as part of an applicant's feasibility and planning studies for proposed undertakings in the OCS could support a more refined characterization of geomorphology within a lease block, and suggest areas to target for archaeological survey. Certainly areas along relict stream channels, estuaries, rock outcrops, and the back sides of drowned barrier islands should receive attention, as should any other areas where paleosols may be identified. In the New York Bight, low sedimentation rates through the Holocene have preserved a submerged landscape in which drainage patterns have been mapped and dated, and subjected to only minimal reworking due to bottom flow and tidal currents (Goff et al. 2005). Thus, landscape features are relatively straightforward to identify, and if archaeological deposits were protected from transgression by prior sedimentation or landform configurations that diverted direct shoreface impacts, they should be recoverable from the seafloor.

6. MIDDLE ATLANTIC

This chapter examines the portion of the Atlantic OCS from Delaware to Myrtle Beach, South Carolina (Figure 6.1). This region is referred to as the Middle Atlantic, and falls mainly within the southern portion of the Middle Atlantic Bight (which runs from Cape Cod, Massachusetts to Cape Hatteras, North Carolina), although it includes the very northern portion of the South Atlantic Bight (between Cape Hatteras and the Myrtle Beach, South Carolina). Prominent geologic or geomorphic features within this region include the Delaware River, Chesapeake Bay, Albemarle Embayment, and Cape Fear Arch.

6.1. REGIONAL GEOLOGY

In the Middle Atlantic study area, the OCS is generally characterized as sloping gradually east to the continental slope. As a consequence of the gradual OCS slope in the study area, rivers, sounds, and bays characterized the environment during much of the Holocene (Browder and McNinch 2006). In conjunction with Holocene sea level rise, sediments associated with those terrestrial features were environmentally resorted, as have the many barrier islands that once existed off earlier coastlines (Heron et al. 1984). In the most general terms, the Middle Atlantic OCS has been described as a “broad sand plain, characterized by a subdued ridge and swale topography” (Shephard 1963). As the shoreline migrated westward, the wave-dominated environment of the region produced a relative equilibrium consisting of subbottom relict sounds, bays, and channels overlain by varying depths of Holocene sand (Riggs et al. 1996; Swift et al. 1972b).

According to Belknap and Kraft (1985:238), coastal Delaware is located on a gently sloping, low-relief coastal plain–continental shelf province that begins inland at the Fall Line and extends seaward to the southeast to the continental shelf break, and consists of a wedge of Mesozoic and Cenozoic sediments that stretches from New York to Virginia (Belknap and Kraft 1985:238). Delaware is on its northwest flank in an arcing trend known as the Salisbury Embayment, which includes parts of Virginia, Maryland, Delaware, and southern New Jersey and is bordered on the north by the South New Jersey arch and on the south by the Norfolk arch (Ward and Powars 2004:263). A major offshore feature of this portion of the region includes the ancestral Delaware River and its tributaries (Belknap and Kraft 1985; Swift 1973; Swift et al. 1972a; Swift and Sears 1974; Twitchell et al. 1977).

Off the coast of Maryland, researchers have used seismic profiles and vibracores to identify likely portions of the ancestral St. Martin River and tributary system (Toscano et al. 1989; Wells 1994), and four significant paleochannels also have been documented offshore of the Delmarva Peninsula. Those channels may have been associated with the relict channels of the Susquehanna, Potomac, Rappahannock, and York rivers, according to a revised model for the geologic evolution of the southern Delmarva Peninsula (Niedoroda et al. 1984). Near the edge of the OCS, bathymetry suggestive of a broad coastal zone similar to the current coastline of the southern Delmarva Peninsula has been identified.

Significant ridge and swale topographic characteristics have been identified south of Cape Henry in the False Cape vicinity of Virginia (Swift et al. 1972a). Additional concentrations of ridges

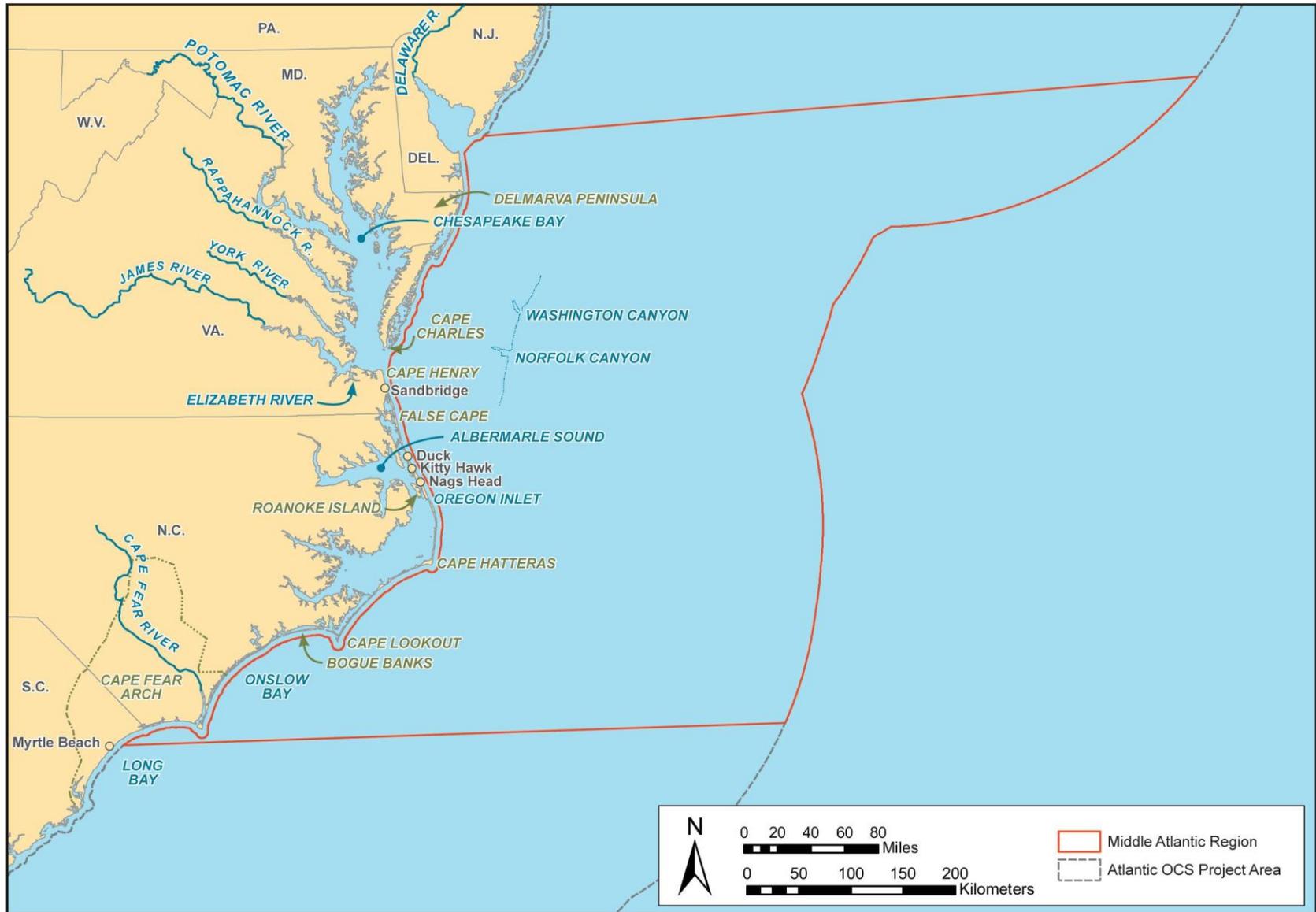


Figure 6.1. Middle Atlantic study region.

and swales are associated with each of the North Carolina capes (Heron et al. 1984; Hunt et al. 1977; Matteucci and Hine 1987). Bunn and McGregor (1980) have identified a regional variation in morphology to the south and offshore of the Albemarle region of North Carolina. There, a smooth, gently dipping, mid-slope morphology is flanked both seaward and landward by steep dissected scarps. On the seaward scarp, associated valleys have cut into the smooth mid-slope region. Well-stratified sediments 500 m thick suggest an association with a significant terrestrial drainage system, possibly associated with paleochannels of the James River (Bunn and McGregor 1980). Additional investigation carried out in the Atlantic between Oregon Inlet and Duck, North Carolina, identified a complex series of relict channels potentially associated with the ancestral Roanoke/Albemarle River and likely formed during the Holocene post-glacial transgression (Boss et al. 2002).

Exceptions to that ridge and swale model can be found to the south in Onslow Bay and south of Cape Fear in Long Bay. Both bays are characterized as high-energy, sediment-starved shelves with extensive exposed hard bottoms. Those hard bottoms consist of outcropping Tertiary and Pleistocene-age stratigraphy (Gayes et al. 2002; Riggs et al. 1996). Research in Onslow Bay indicates that the Holocene coastal lithosomes are virtually non-existent on the inner and middle portions of that area of the OCS. Tertiary-age stratigraphy is exposed on much of the sea floor, but a 1–3 m Pleistocene-age sequence unconformably overlies those sequences on the inner shelf offshore of Bogue Banks. Relict channels in the area, for the most part, represent streams on the lower Coastal Plain that filled with fluvial and estuarine sediments during the mid-Pleistocene. No evidence of Holocene-age barrier-related material was found within the channels (Hine and Snyder 1985).

Near the extremity of the OCS, east-southeast of Cape Lookout and southeast of Cape Fear, submerged terraces have been found (Matteucci and Hine 1987). Investigation of the OCS near Cape Fear identified the remains of several large river channels and numerous smaller river channels. The location and orientation of those relict channels suggest that the Cape Fear Terrace represents the remains of a paleo shelf-edge delta. Although not as complex, the Cape Lookout terrace could be a similar feature.

6.2. RELATIVE SEA LEVEL RISE

Early summaries of the Holocene marine transgression rates for the Middle Atlantic are presented by Belknap and Kraft (1977), Edwards and Merrill (1977), and Edwards and Emery (1977), with more recent work by Ramsey and Baxter (1996) and Nikitina et al. (2000) for the Delaware area, Van de Plassche (1990) for Virginia, and Mallinson et al. (2005) and Horton et al. (2009) for North Carolina.

While the more recent work employs additional samples and more refined dating methods, there remains difficulty in assessing sea levels ca. 12,000 B.P. and earlier because of a lack of data points. Given a lack of relative sea level data for the region at the LGM, it is assumed to correspond to the eustatic curve for the Atlantic based on the Barbados data, placing sea level at approximately 120 m lower at the LGM (Bard et al. 1990b; Fairbanks 1989). Assigning a corresponding relative sea level for the period from the LGM to ca. 11,000 B.P., however, is problematic for the region. The oldest index reported by Horton et al. (2009:1728) for North Carolina, for example, is dated to approximately 10,800 B.P. and places relative sea level at

36 m below current sea level. Nikitina et al. (2000:Figure 4) have suggested that by 12,000 B.P. sea levels were only 30 m below present. Unfortunately, there is a lack of index points for start of the Paleoindian period (ca. 13,000–12,500 B.P.), when human occupation was certain in North America.

Lowery (2009) has suggested that isostatic depression of the former glacial forebulge likely played a role in sea levels ca. 13,000 B.P. in the Middle Atlantic region, with the effects being more prevalent in Delaware and tapering off to the south. This assumption is supported by Reusser et al. (2004), who suggest that the observed rapid bedrock incision rates associated with isostatic uplift during the LGM ceased along the Susquehanna and Potomac rivers ca. 14,000 B.P. By 14,000 B.P., the Laurentide forebulge that had previously impacted the unglaciated areas south of the ice sheet's terminus had fully collapsed, and the bulge seems to have been followed by an isostatic trough or depression. Precisely how this depression impacted sea levels ca. 13,000 B.P. remains unclear, however.

To resolve the lack of data on sea levels ca. 13,000 B.P., the curves developed for New Jersey are employed here. Wright et al. (2009), as developed by Nordfjord et al. (2009), indicate that sea levels were approximately 70 m lower ca. 13,000 B.P. Sea levels likely would have been more shallow due to isostatic depression ca. 13,000 B.P., and but until additional research is conducted to develop additional data points, 70 m provides a conservative isobath to assume for the beginning of the Paleoindian period for this region.

At the beginning of the Holocene, ca. 10,000 B.P., sea levels were approximately 30 m below present (Horton et al. 2009; Mallinson et al. 2005; Nikitina et al. 2000). These studies also put sea level at -15 to -18 m ca. 8000 B.P., and by 6,000 B.P. sea level had risen to around 10 m below present.

6.3. MARINE TRANSGRESSION AND SITE PRESERVATION

Sea level data provide a window into understanding where to look for drowned archaeological sites on the continental shelf. One can assume that coastal resources would be abundant and humans would be attracted to shoreline areas during periods with slow sea level rise rates. However, coastal archaeological sites would have a higher chance of erosion and destruction during these same stable sea level periods. During periods of rapid sea level rise, the productivity of coastal ecological systems would drop significantly and humans would tend to favor subsistence areas outside of the Coastal Plain. Even so, landscapes with archaeological sites would be rapidly inundated and preserved (Lowery and Martin 2009).

The highest rate of sea level rise during a period of known prehistoric occupation along the Middle Atlantic is associated with MWP 1b, which best estimates currently place at 11,600–11,100 B.P. (see discussion in Section 1.5 in Chapter 1 above). This period, which based on sea level curves for the region corresponds to 55–42 m isobaths, experienced rapid sea level rise averaging 200–300 cm per year (Lowery 2009), and represents a time when intact archaeological sites may have had a better chance of being inundated rapidly and preserved. This period was followed by a much slower rate of sea level rise (approximately .8 cm per year) until ca. 7000 B.P., after which the rate of sea level rise slowed even further (0.2 cm per year or less). During

this period, archaeological sites presumably would have a higher frequency of erosion or destruction by the process of marine transgression.

Lowery (2001, 2003, 2008, 2009) has argued that areas along the Middle Atlantic that demonstrate evidence of wide, or broad coastal zones during the prehistoric period may be indicative of high site density, with increased possibility that sites may be preserved. A broad coastal zone includes a coastal barrier island backed by a large shallow bay with many dendritic tidal channels. The limited tidal marsh in these regions creates compartmentalized bays that act as storm buffers. As such, broad coastal zones provide excellent shellfish habitat as well as habitat for other coastal organisms. A narrow coastal zone, on the other hand, includes a coastal beach with a confined back-barrier island area that includes extensive tidal marsh and many deep tidal creeks. Narrow coastal zones provide limited shellfish habitat. Because of the close proximity to the ocean, shellfish habitat areas would be greatly limited by frequent storm-related overwash events.

Perhaps the most likely area for preserved prehistoric sites on the Middle Atlantic OCS lies off the Delmarva Peninsula flanking the Norfolk and Washington canyons (Figure 6.2). Bathymetry indicates that this area is an isobathic region that contains broad coastal zone characteristics, where sites were likely to exist. The high probability area extends from south of the Norfolk Canyon to the Virginia/Maryland border of the Middle Atlantic OCS study area. As such, one can conclude that these possible site settings were situated along broad open-barrier island lagoons approximately 13,000 B.P., where site burial was highly possible. Two specific high probability locations have been isolated based on those criteria (see Figure 6.2).

In addition, the head of the Norfolk Canyon appears to be relatively unique in relation to the other Middle Atlantic OCS canyons (the Washington Canyon and the Keller Canyon). At the head of the Norfolk Canyon, there appears to be a large relict lagoon complex. Multi-beam data from a NOAA survey carried out with funding from the NOAA Office of Ocean Exploration (NOAA Grant Number NA07OAR4600293) generated the first high detail, multi-beam images of the head of the canyon and surrounding area (Figure 6.3). That area also appears to be a high potential location for association with Paleoindian habitation based on the nature of relict landforms identified in predictive models for inundated Paleoindian site locations developed by Faught (2003), Faught and Latvis (2000), Pearson et al. (1986), Lowery (2009), and Stright (1990).

South of the Norfolk Canyon available bathymetry suggests that there are no areas similar to those off the Delmarva Peninsula. The zone associated with possible prehistoric habitation is narrow and not suggestive of an environment attractive to prehistoric populations. However, two additional potential high probability sites for association with Paleoindian activity on the Middle Atlantic OCS have been identified. The first is located southeast of Cape Lookout, North Carolina, and is found in Figure 6.4. While not nearly so complex as the high probability area off Virginia, bathymetry indicated that one or more islands may have existed in conjunction with a moderate size lagoon complex that could have been attractive to Paleoindian inhabitants. A third area southeast of Cape Fear may also merit consideration. Bathymetry in the area identified as the Cape Fear Terrace is suggestive of an island complex (Figure 6.5). Although there is little to suggest an association with a large lagoon, the feature represents a distinctive variation from the paleolandscape extending north to Cape Lookout and south to the South Carolina border.

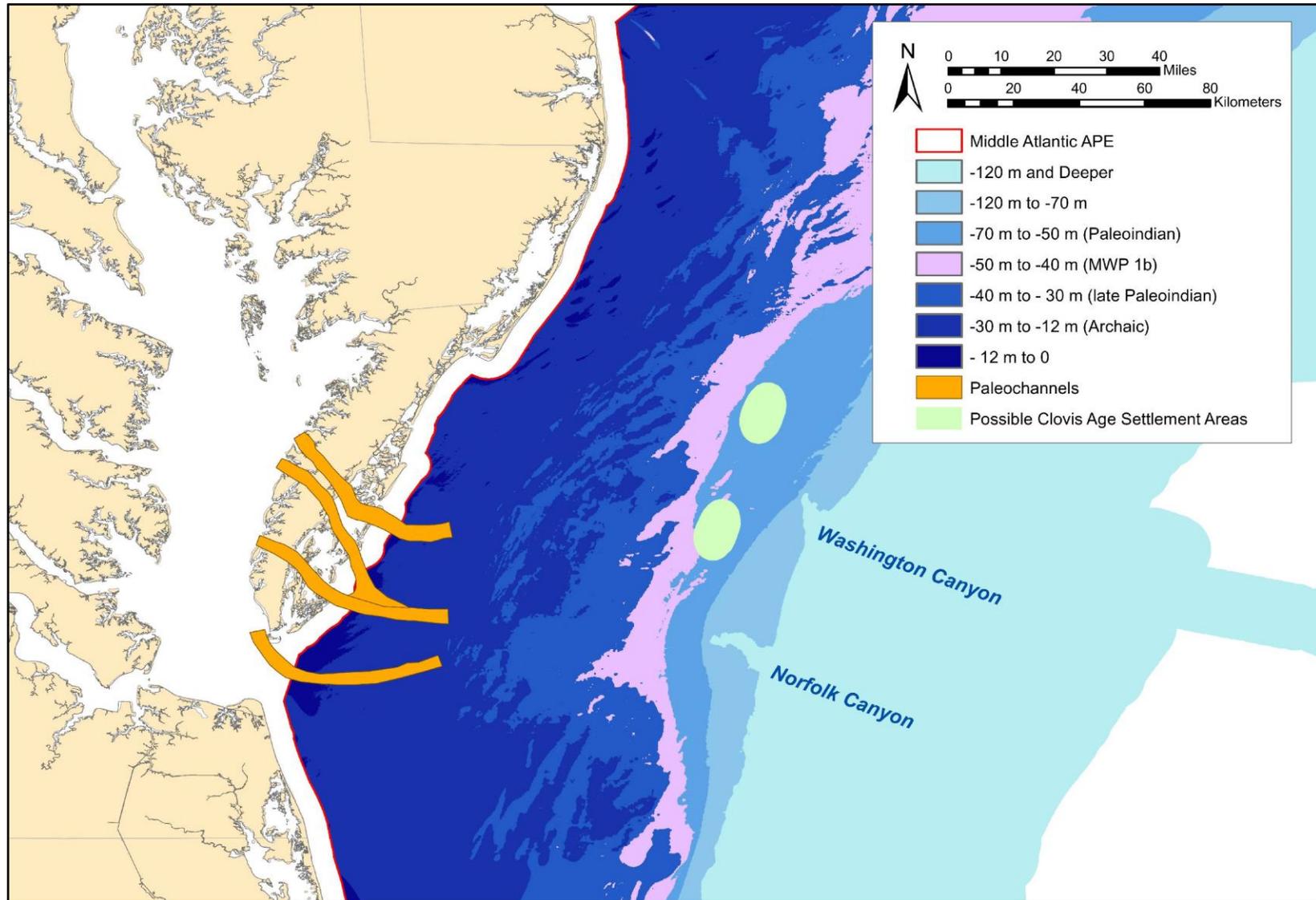


Figure 6.2. High priority area off the Delmarva Peninsula flanking the Norfolk and Washington canyons showing high potential areas for Paleoindian habitation, including the area inundated during the MWP 1b event.

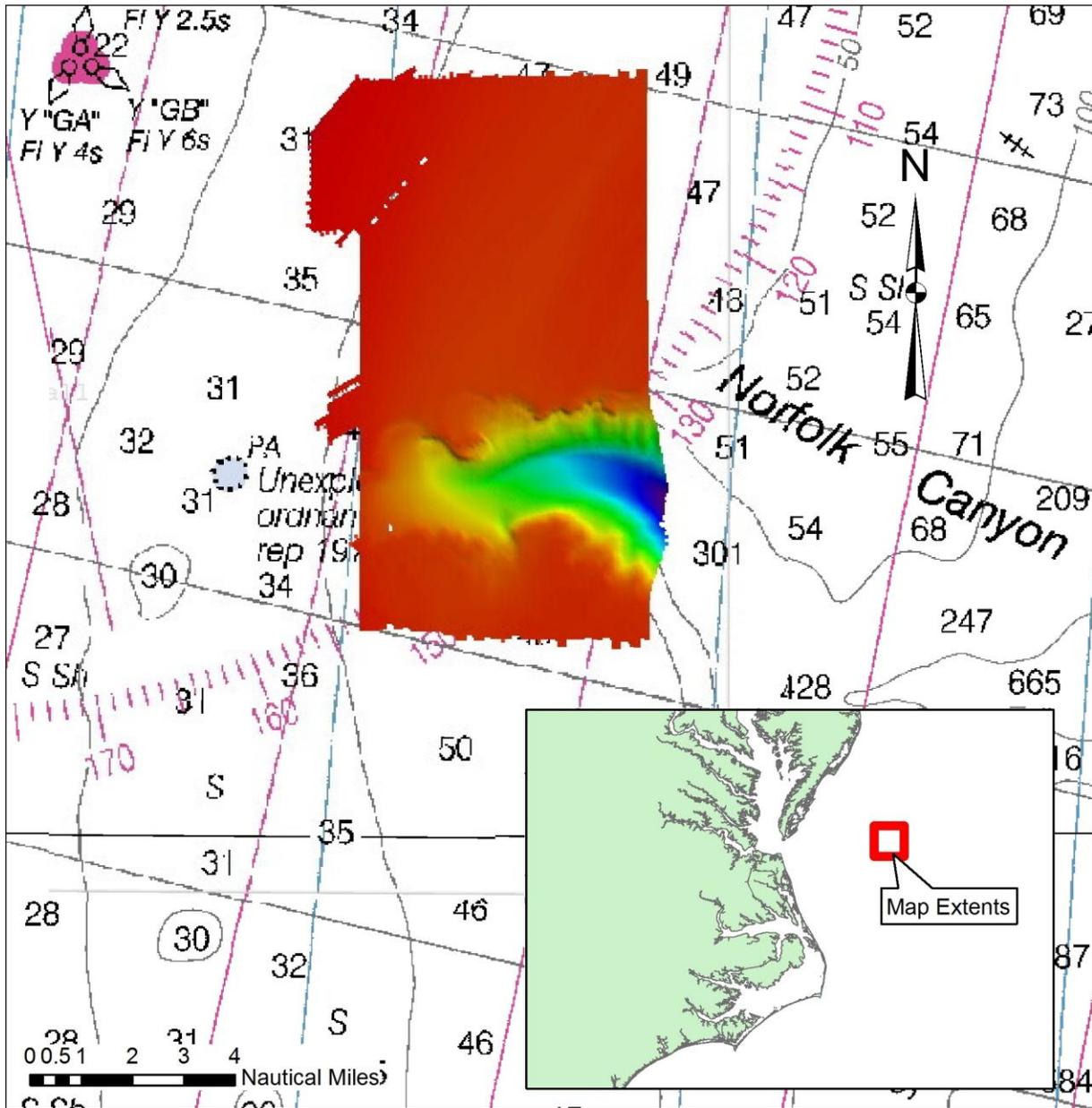


Figure 6.3. Head of the Norfolk Canyon imaged with multi-beam 2008 (NOAA Chart No. 12200 used as base map).

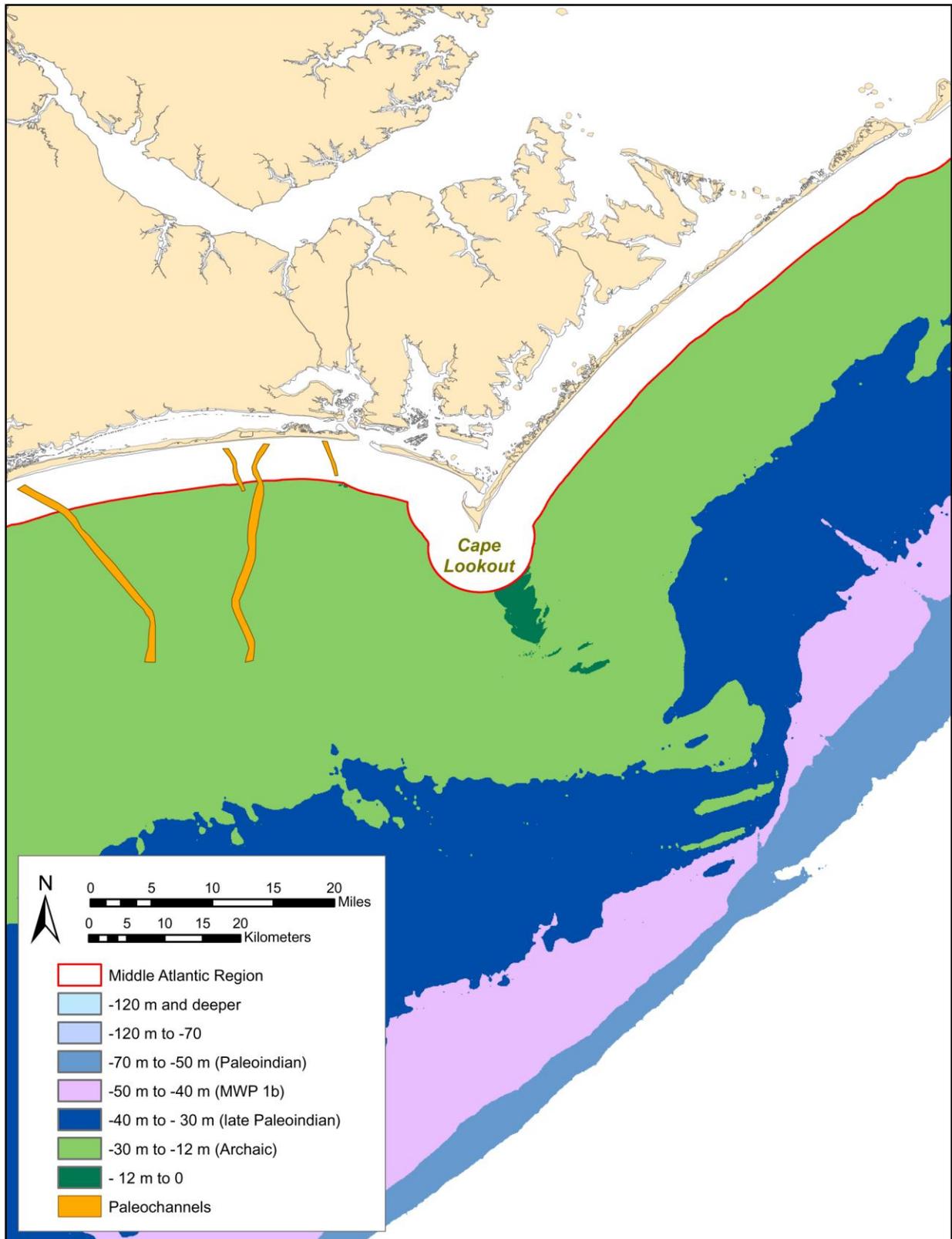


Figure 6.4. High potential, terrace-associated area south-southeast of Cape Lookout, North Carolina.

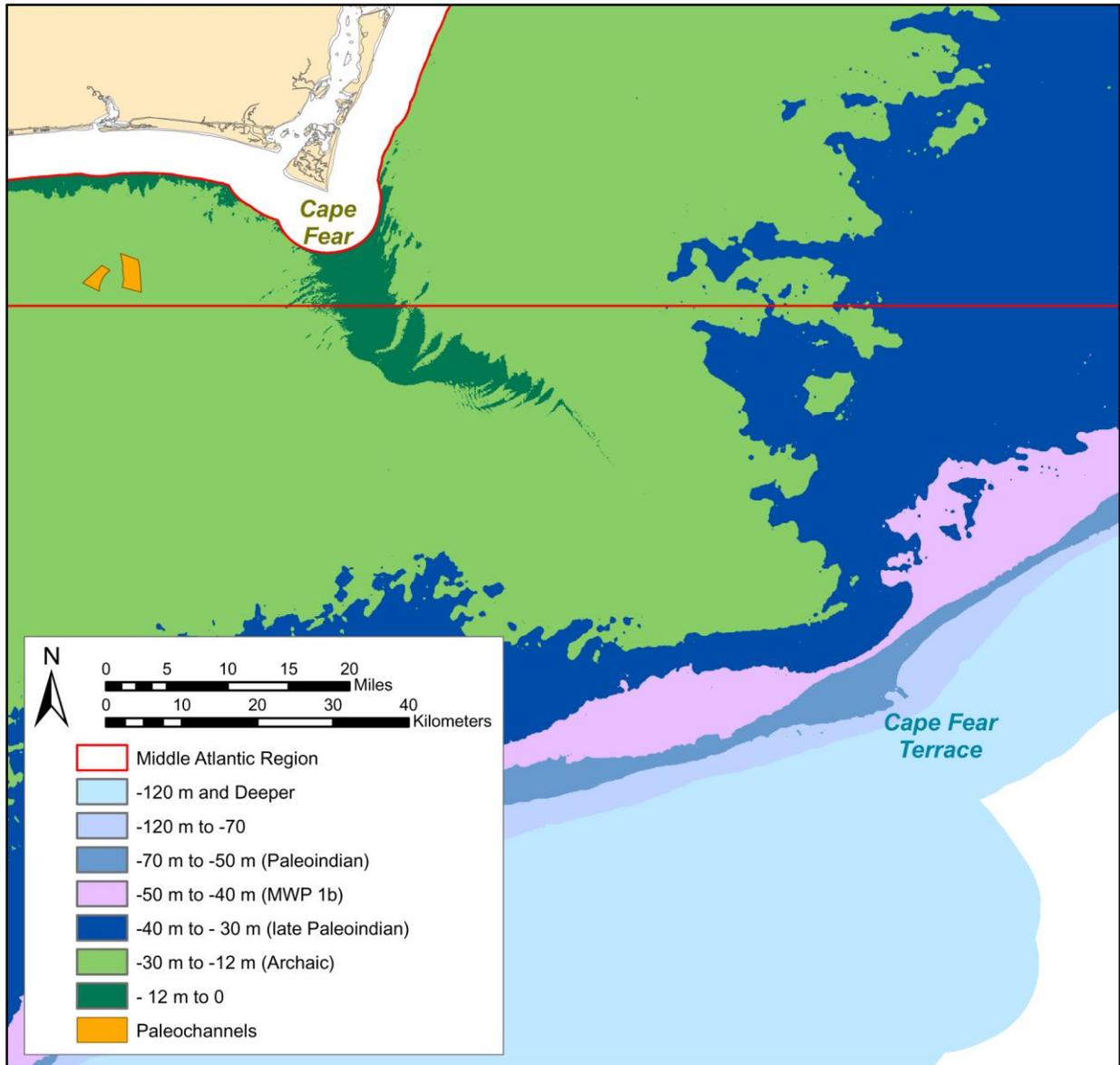


Figure 6.5. High priority feature identified as the Cape Fear Terrace.

The remainder of the submerged coastline at depths associated with the Delmarva, Cape Lookout, and Cape Fear priority areas appears to be too narrow and lack the features suggestive of a broad coastal zone environment that would have been attractive to Paleoindian populations. However, immediately inshore in the area rapidly inundated by MWP 1b, evidence of Paleoindian habitation could survive. While rapid inundation might have reduced occupational desirability of the area, pre-MWP 1b occupation sites could survive the more limited adverse impacts associated with rapidly rising sea levels.

Inshore of the MPW 1b zone and offshore of the early Holocene sea level rise, an extensive portion of the Middle Atlantic OCS consisting of approximately 4,700 square miles was exposed and proportionally habitable for over 3,000 years as sea level slowly rose. Unfortunately, due to the slow rise in sea level, that area was exposed to all of the destructive environmental conditions

that obscure, reduce, or destroy landforms and undermine archaeological site integrity. Offshore of the Delmarva Peninsula, identified paleochannels reflect four iterations of the Susquehanna River. The oldest, Exmore Channel, underlies the peninsula and extends into the OCS approximately 30 miles north of Cape Charles. Bell Haven Channel, Eastville Channel, and Cape Charles Channel, each progressively farther south and younger, underlie the peninsula and appear on the OCS as well (Chen et al. 1995; Colman et al. 1990; Dame 1990; Hobbs 1997, 2004; Oertel and Foyle 1995). On the OCS these and other relict channels could have associated prehistoric material. Although as previously discussed, channel features such as levees where habitation might be expected could have been extensively resorted during inundation, Stright suggests that this is not necessarily always the case (Stright 1990). Along the present foreshore, those channels could have surviving Archaic material.

Subaerial surfaces between Cape Henry and Cape Hatteras have been extensively eroded and redistributed during the shoreface retreat. The area also has been impacted by fluvial erosion associated with the tributaries of the Susquehanna River and meltwater runoff (Moir 1979:44). In the Sandbridge, Virginia area below Cape Henry, evidence of relict landforms also have been identified. Virtually all of those consist of river and stream channels and estuary complexes possibly associated with the paleo-James River or the paleo-Elizabeth River (Chen 1992; Dame 1990; Harrison et al. 1965; Hobbs 1990; Kimball and Dame 1989; Meisburger 1972; Swift 1975). Under certain conditions, associated archaeological evidence could survive in a relatively undisturbed context.

Lagoonal deposits dating as early as 10,000 B.P. have been identified offshore of the North Carolina Outer Banks, adjacent to Roanoke Island. Those deposits were associated with Platt Shoal, a retreat massif on the north side of the ancestral Albemarle Valley (Moir 1979:44). Nearshore evidence of paleochannels in the vicinity of Nags Head, Kitty Hawk and Duck, North Carolina, and Sandbridge, Virginia, was identified by Browder and McNinch (2006). Farther south, another series of paleochannels extending from Bogue Banks into the OCS have been identified in Onslow Bay by Hine and Snyder (1985). In the vicinity of Cape Fear, relict channels of the Cape Fear River cross the OCS in an area between Onslow Bay and Long Bay that is not characterized by sediment starvation. Although untested, surviving landforms associated with relict channels could contain prehistoric material.

It is difficult to reliably identify high priority upper shelf locations for OCS Paleoindian and Archaic habitation, but the areas noted are worthy of consideration. Those areas could produce hard data that can be used to test predictions that associate relict landforms and prehistoric sites. In theory, relict landforms such as rivers, lakes, bays, and lagoons could be associated with particular types of archaeological sites (Stright 1990). Those “terrestrial analogs” are based on land-use patterns from archaeological evidence associated with terrestrial prehistoric sites (Gardner 1980, 1982) and can be used to identify potential habitation sites on the OCS (Belknap 1983; Bonnicksen et al. 1987; Cockrell 1980; Drago 1976; Faught 2003; Faught and Latvis 2000; SAI 1981).

6.4. ARCHAEOLOGICAL SENSITIVITY AND PRESERVATION POTENTIAL

Based on the most current sea level curves for this region, archaeological sensitivity is defined as follows, and is displayed in Figure 6.6:

- **No Sensitivity.** Areas 120 m and greater in depth are considered to be areas with No Sensitivity for prehistoric sites, since these areas were not subaerial during the LGM.
- **Low Sensitivity.** Areas from the 120 m to 70 m isobaths. This designation covers areas exposed between the time of the LGM and the earliest Clovis occupation, ca. 13,000 B.P.
- **High Sensitivity.** High Sensitivity areas include all areas within the OCS that are shallower than 70 m.

As discussed in Section 6.3 above, there are a number of locations within the High Sensitivity areas that also have High Potential for containing sites. Such locations include areas in the vicinity of paleochannels and relict terraces off of Cape Fear and Cape Lookout (see Figures 6.2–6.5). Figure 6.7 illustrates the relative sea levels during the past 20,000 years, including the high potential area associated with rapid sea level rise during MWP 1b, which corresponds to the 55–42 m isobath range, and should be considered High Potential for site preservation.

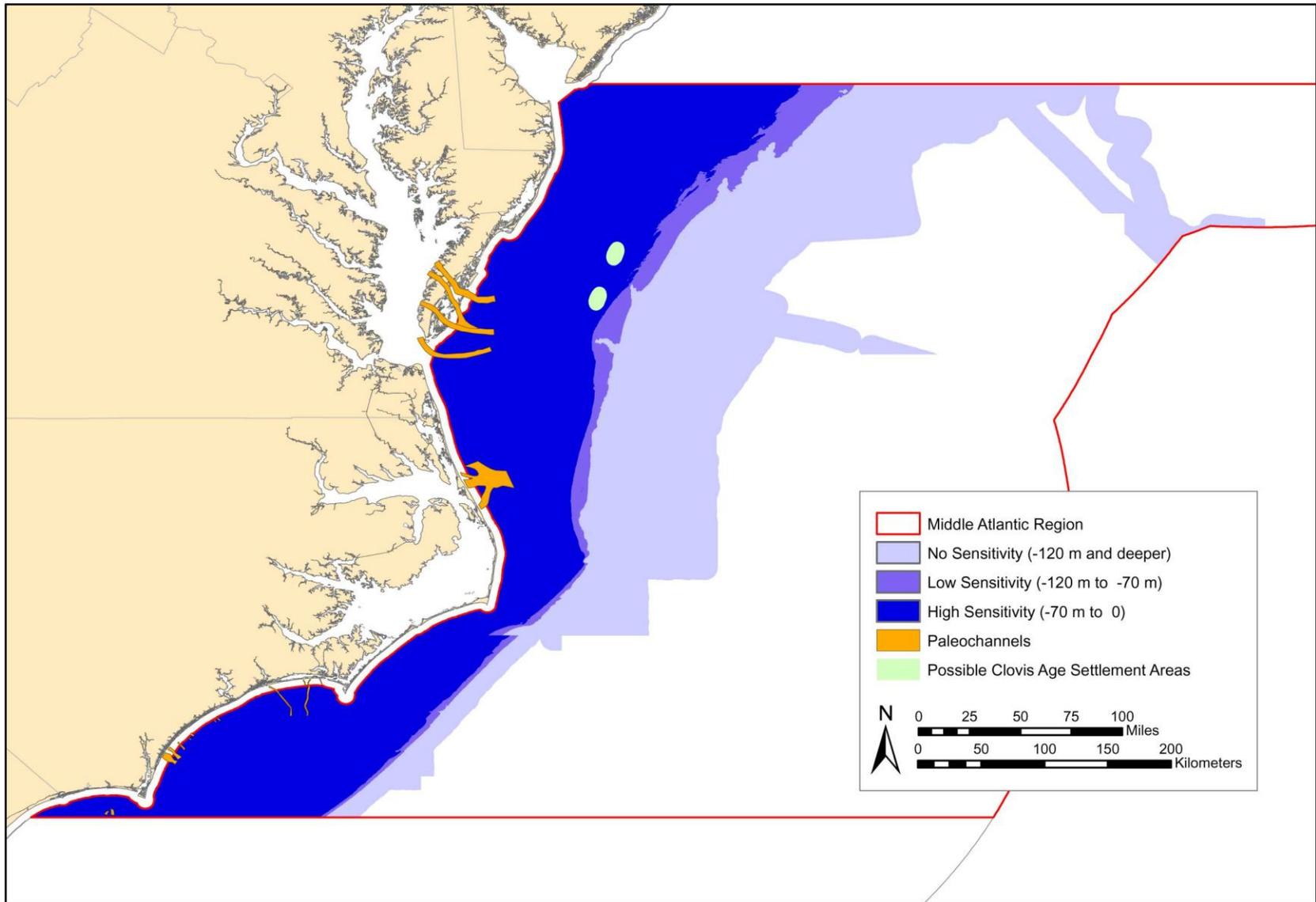


Figure 6.6. Archaeological Sensitivity map for Middle Atlantic study region.

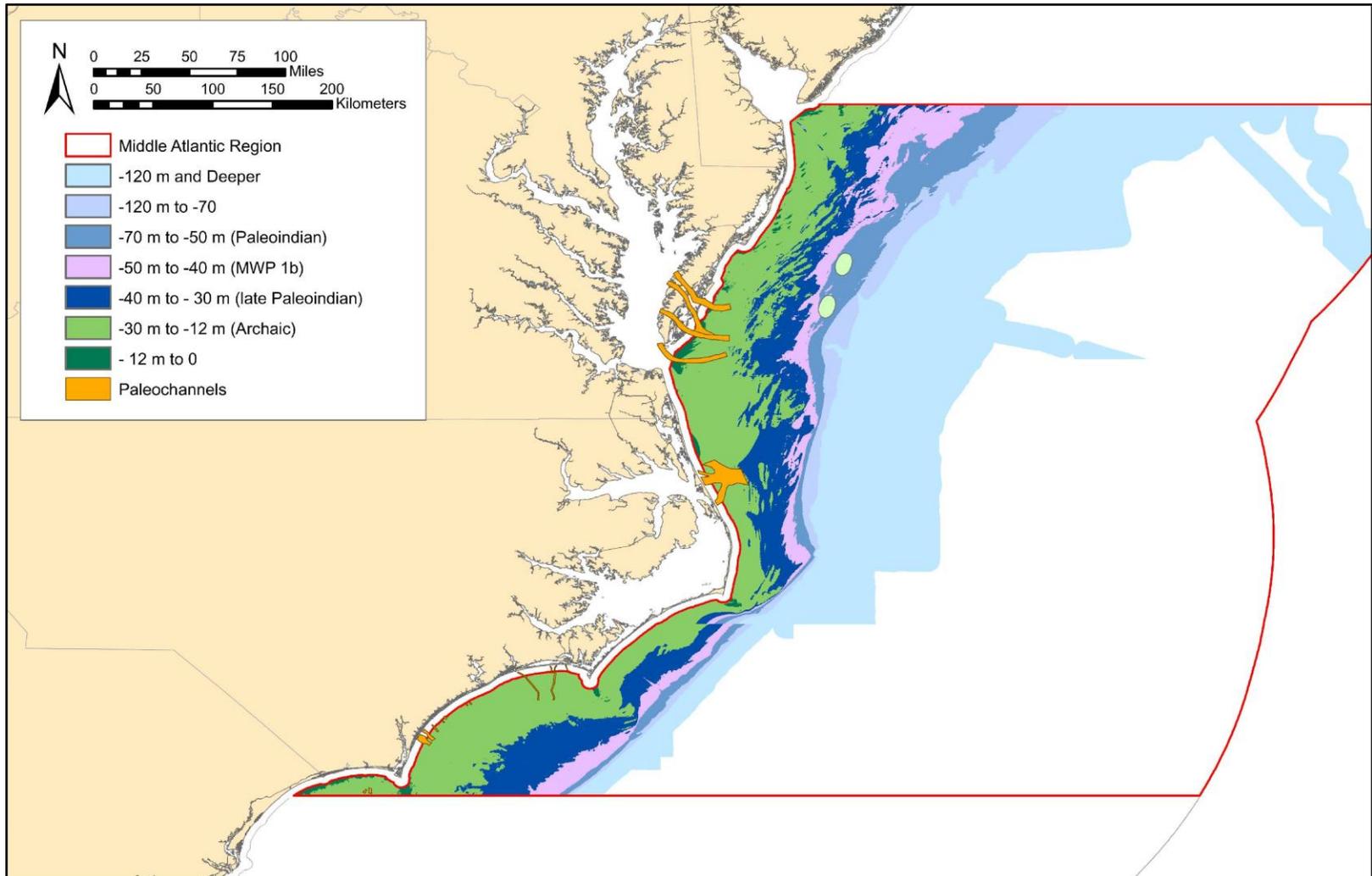


Figure 6.7. Sea levels for specified periods, including High Potential area corresponding to MWP 1b in the Middle Atlantic study region.

7. GEORGIA BIGHT

The Georgia Bight is a sub-division of the South Atlantic Bight; for purposes of this chapter, the Georgia Bight study region is defined as that portion of the South Atlantic Bight that lies between Myrtle Beach, South Carolina, and Georgia–Florida border in the vicinity of St. Marys, Georgia (Figure 7.1).

7.1. REGIONAL GEOLOGY

The Georgia Bight can be described as an embayment portion of a passive continental margin characterized by a thin sedimentary layer overlying a Cenozoic geology made up of extensive yet condensed sections that have resulted from paleo-oceanographic processes (Adesida 2000; Baldwin et al. 2006; Garrison et al. 2008; Harris et al. 2005; Henry n.d.; Littman 2000; Weems and Edwards 2001; Weems and Lewis 2002). This embayment is mildly up-warped on the north by the Cape Fear Arch at latitude 33° 30'; it is down-warped south of this latitude until in the south, at 30°, this margin rises again with the Florida carbonate platform. None of the change in elevation for the Georgia Bight is dramatic, with uplifted coastal terraces rarely reaching 30 m. Active fault systems are few, with the Charleston Fault being the most prominent. Weems and Lewis (2002) describe a north-trending fault south of the Charleston Fault forming a discrete hinge zone that accommodates structural movement between the Cape Fear Arch and the Southeast Georgia embayment. Uplift, while minimal, does occur in the Georgia Bight.

The regional geologic framework for the Georgia Bight encompasses 18 stratigraphic units from the Oligocene to the Pliocene in the coastal area of Georgia, and 11 Eocene through Pliocene units off Charleston. Near the area of the Cape Fear Arch, Paleocene outcrops have been identified (Weems and Edward 2001; Weems and Lewis 2002). The Georgia Bight continental shelf is dominated by sediments, unconsolidated and consolidated, that are eroded relicts of earlier subaerial coastal landforms characterized by dunes, wetlands, coastal rivers, and forests much like today (see, e.g., research by Baldwin et al. 2006; Colquhoun et al. 1983; Foyle and Henry 2004; Garrison et al. 2008; Gayes et al. 1992; Harris et al. 2005; Markewich et al. 1992; Riggs et al. 1992, 1996; Swift 1976; Swift et al. 1972b; Weems and Edwards 2001; Weems and Lewis 2002). The proximal cause of the erosion of these coastal landforms is sea level change, either the transgression or regression limbs of a highstand–lowstand sequence (Johnson and Baldwin 2004:235–280). Indeed, the Georgia Bight as a geomorphic surface has much in common with that of the Middle Atlantic Bight to its north. The Middle Atlantic Bight sandsheet, and that of the South Atlantic Bight/Georgia Bight, is the result of sea level rise (transgression) with landward retreat of coastal barrier and estuarine systems along with sediment reworking by storm-, tidal- and wind-generated bottom currents (Garrison et al. in press; Riggs et al. 1996; Swift 1976; Swift et al. 1972b).

The Georgia Bight, like most of the eastern U.S. continental shelf, is characterized as an accommodation-dominated shelf, wherein flooding and ravinement during transgression is dominant. While there is space or depth available for the influx of terrigenous sediments during sea level highstands (i.e., sediments derived from erosion of the continents), the lack of large rivers with large sediment loads precludes the buildup of sediments transported from elsewhere in favor of the reworking of existing sediments. The Georgia Bight is a shelf dominated by

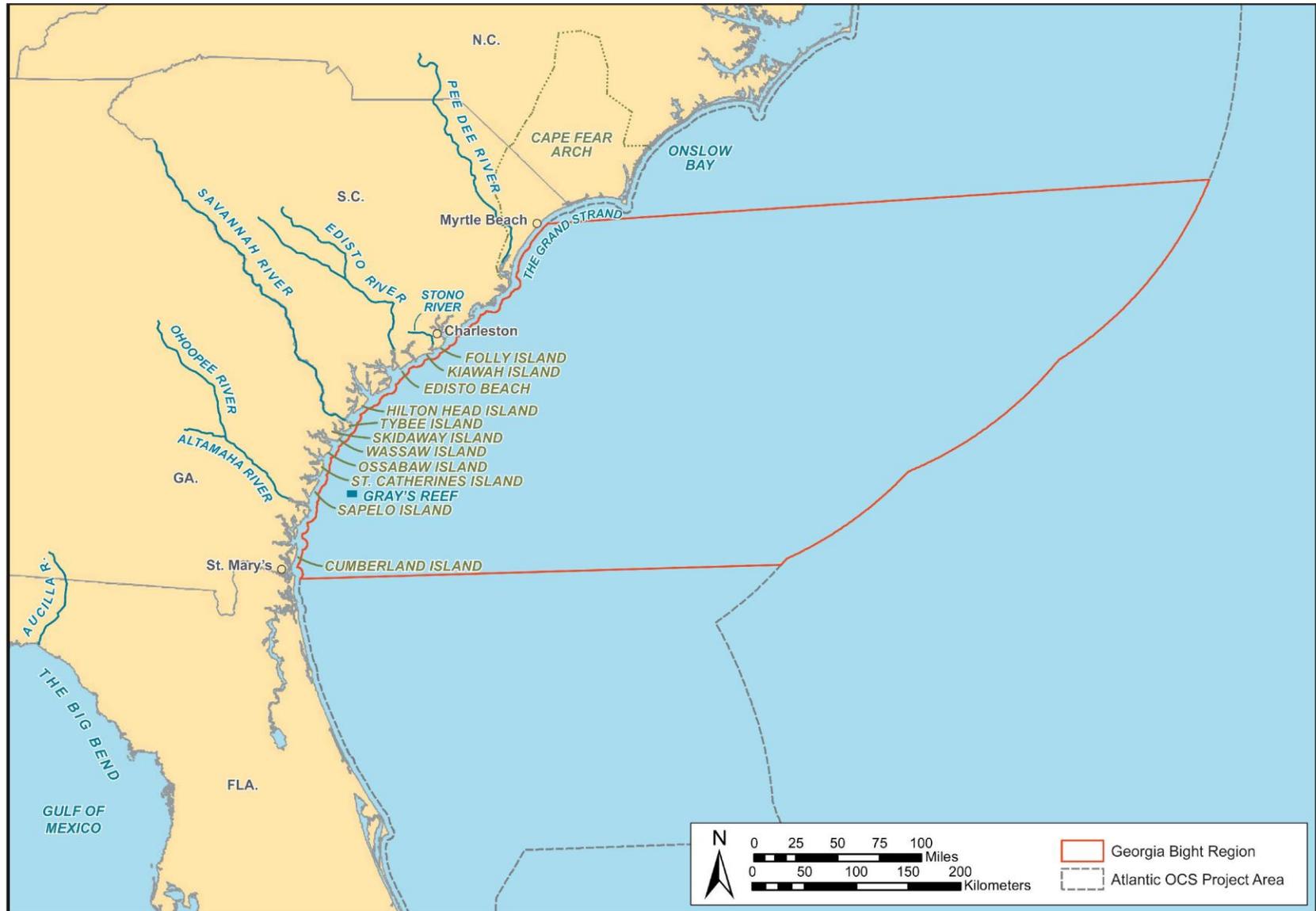


Figure 7.1. Georgia Bight study region.

erosional accommodation, with a sea floor in disequilibrium with erosional surfaces, irregular grain size patterns, shoreface bypassing, and wave/wind and tidal current reworking. Additionally, recent studies (e.g., Baldwin et al. 2006; Harris et al. 2005; Weems and Lewis 2002) have shown that this shelf is characterized by a stratigraphic heterogeneity. Indeed, in many areas the Miocene and Pliocene units are scattered as erosional remnants. In other areas, such as the mid-to-outer shelf, these units outcrop as ledges and erosional ramps. Riggs et al. (1996) attribute this shelf morphology to subaerial weathering, stream erosion, and karst formation. The latter is most notably observed on the Florida portion, which has a rugose shape (Adams et al. 2010).

The Cenozoic aged geologic units that underlie the unconsolidated Quaternary age sediments of the inner-to-mid shelf are well described in studies onshore along the Georgia and South Carolina coasts. These formations span the post-Cretaceous time interval, with the most described units being of Eocene through Quaternary age (54.5–2.588 million years ago), but with Paleocene units (up to 65 million years ago) occurring on the northern portion at the Cape Fear Arch. Figure 7.2 depicts those geologic units that are present to a greater or lesser degree along the Georgia shoreline and offshore.

Nearshore, the seafloor exposures consist of Pliocene-age rocks that are members of the Raysor Formation. Offshore, it replaces the Cypress Head Formation that pinches out or has eroded out as one traces it onto the Georgia Bight shelf, where it has been eroded. Hard bottom exposures of Pliocene age outcrops are common along the 20 m isobaths (Figure 7.3). The amount of hard bottom has been estimated in the SEAMAP study (2001), and these data have been incorporated here.

Much like Riggs et al.'s (1996) findings at Onslow Bay, North Carolina, within the Middle Atlantic Bight, outcrops and hard bottoms are interspersed with large coextensive areas of sand. Weaver (2002) recovered up to 3 m of unconsolidated sands in vibracores at Gray's Reef, off the coast of Georgia. These results are similar to those reported by Gayes and other researchers for the Middle Atlantic Bight (Gayes et al. 1992). Sautter and her students at College of Charleston have explored and recovered rock samples from the scarp areas of the Middle Atlantic Bight/Georgia Bight shelf break (Stubbs et al. 2007). One of these samples has been examined recently and compared to rock samples from mid-shelf locales. If one extrapolates the known lithostratigraphy for the Georgia Bight to the shelf break area (e.g., Adesida 2000; Henry n.d.; Huddleston 1988; Weems and Edwards 2001; Woolsey 1977), those outcrops are Miocene in age.

In both hand and thin section, the rock exposures of the mid shelf and outer shelf are lithologically calcarenites as a rule. There is variability, but the clastic nature of these rocks is medium-to-coarse quartzitic sands cemented in a carbonate matrix of spar or micrite (Garrison et al. 2008; Harding and Henry 1994; Hunt 1974) (Figure 7.4).

As Swift (1976; Swift et al. 1972b) initially postulated and later studies have confirmed (Baldwin et al. 2006; Garrison et al. 2008; Harris et al. 2005; Henry n.d.; Woolsey and Henry 1974), the Georgia Bight, like the Middle Atlantic Bight (Riggs et al. 1992, 1996), is incised with Coastal Plain rivers. Their paleochannels are incised into Pliocene–Miocene strata (Foyle et al. 2001; Foyle and Henry 2004; Henry n.d.; Woolsey and Henry 1974). One major effort in the

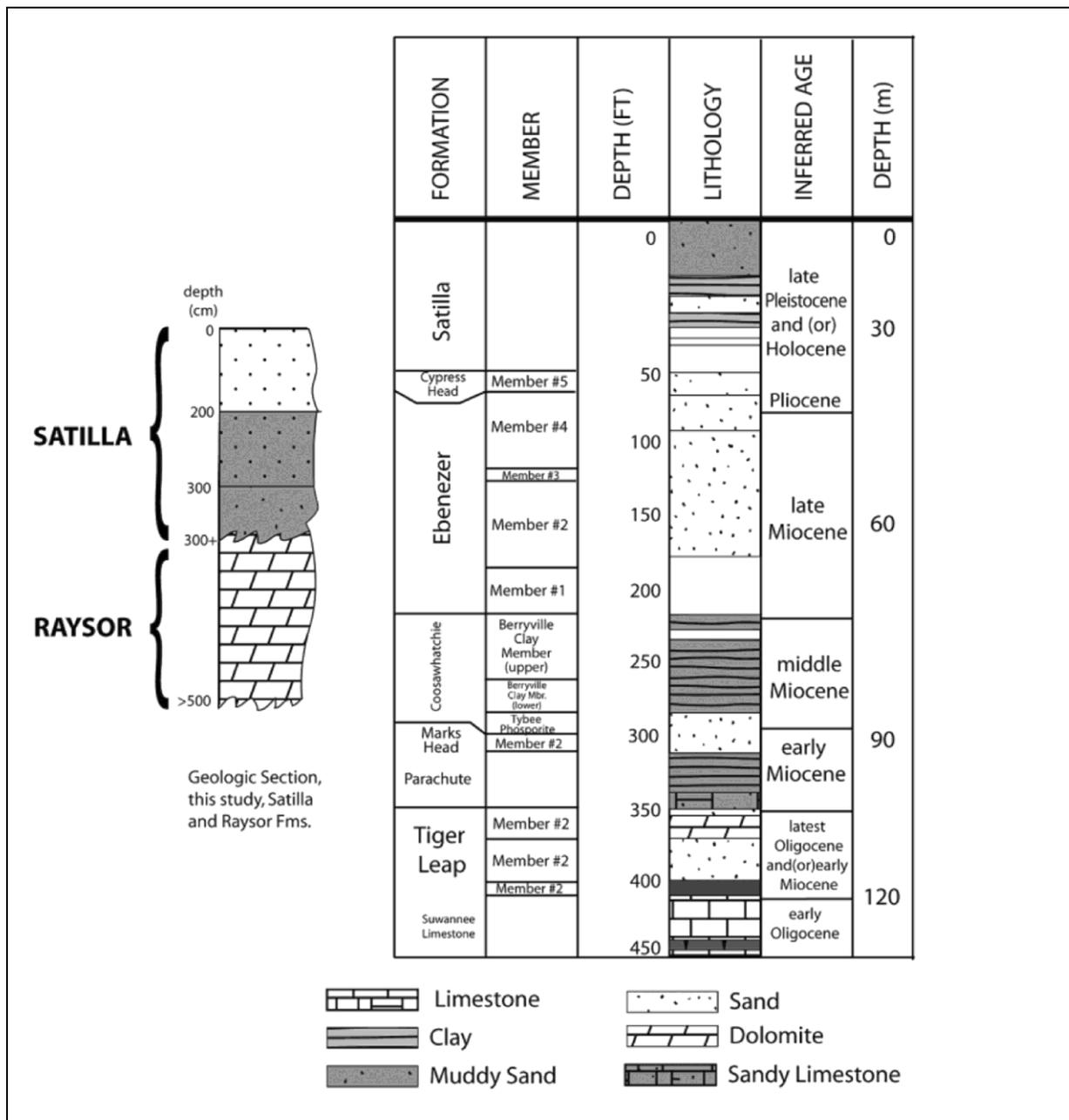


Figure 7.2. Generalized geological section for coastal Georgia from Oligocene through Pleistocene (adapted from Weems and Edwards [2001] and published in Garrison et al. [2008]).

present study was to consolidate existing information, seismic and otherwise, to better define these paleochannels. As shown in Figure 7.5, these efforts identified the Paleo-Altamaha, the Paleo-Savannah, and the Paleo-Medway river courses off Georgia and those paleo-streams detected for the Stono-Edisto and Pee Dee river systems in the north half of the Georgia Bight. It is instructive to note the close correlation of these streams with those postulated by Swift (Swift 1976; Swift et al. 1972b) using bathymetric variation.

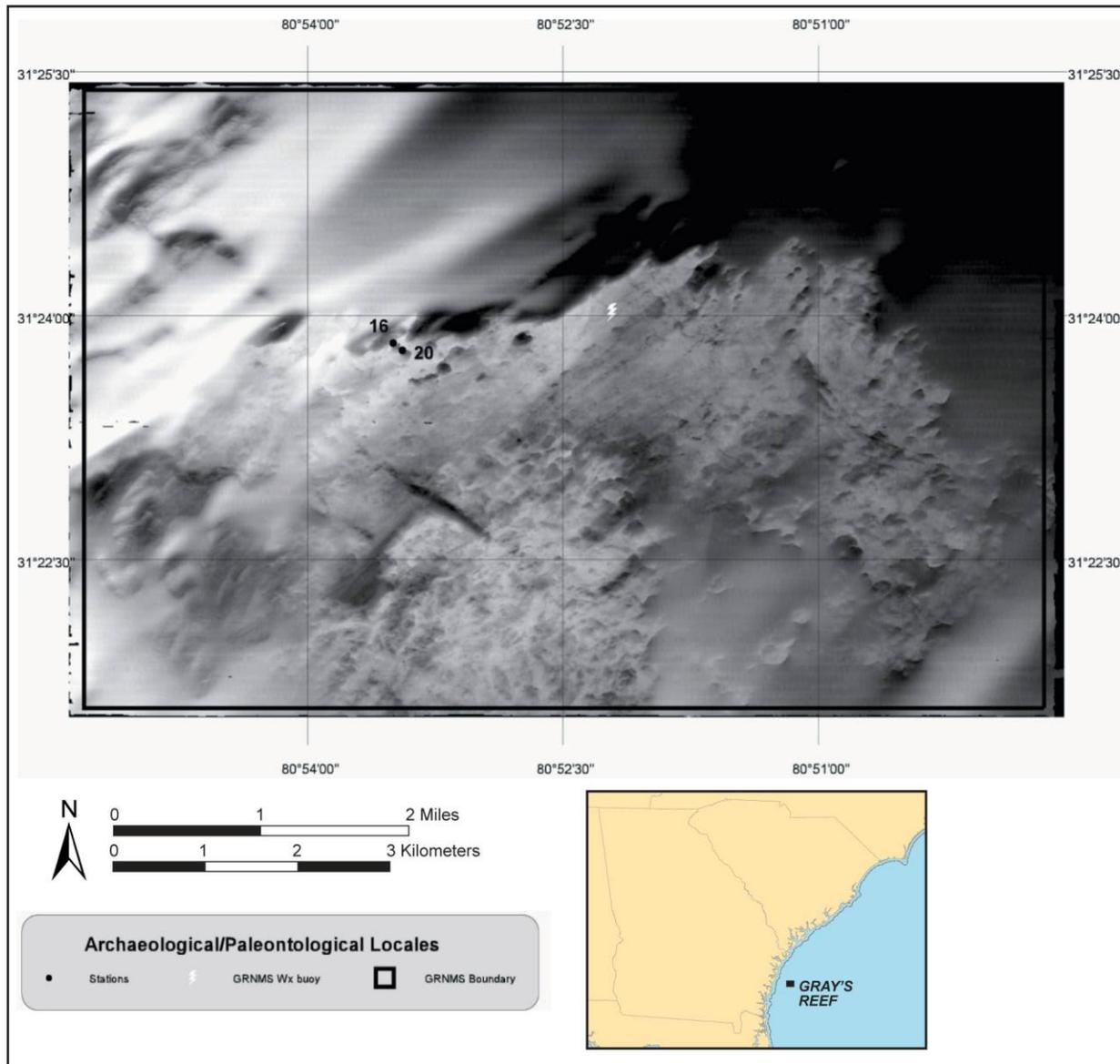


Figure 7.3. A multibeam sonar image of hardbottom exposures at Gray's Reef National Marine Sanctuary off the Georgia coast, with archaeological locales (16, 20) shown.



Figure 7.4. Thin section (left) and hand section (right) of medium-to-coarse quartzitic sands cemented in a carbonate matrix of spar or micrite from the OCS of the Georgia Bight.

The predominant sediments in the Georgia Bight are those of Pleistocene/Holocene age. These sediments extend onto the continental shelf to the mid shelf (-20 m). Outcrops, hard bottoms, and paleo-valleys are primarily of Pliocene age until outer shelf/shelf break depths are reached. Here, the strata are predominantly Miocene age. Northward along the shelf margin, Miocene strata will outcrop shoreward onto the inner shelf because of the thinning and/or erosion of Quaternary and Pliocene age strata. Figure 7.6 shows a north-to-south thinning-to-thickening of Pliocene age sediments from a few meters thickness off Tybee Island to over 30 m off Sapelo Island, based on seismic data. Foyle and Henry (2004) attribute this deepening of Pliocene deposits in an elongate coast-parallel embayment. This embayment extends landward behind the present day barrier system. Thinning of Quaternary age deposits near Savannah is attributed to the presence of the Beaufort Arch, similar to the deposits near the Cape Fear Arch farther north.

Henry (n.d.), in Figure 7.6, has interpreted seismic data for the inner-to-mid shelf north of Sapelo Island, Georgia, to Hilton Head Island, South Carolina. In this previously unpublished figure, seismic facies are interpreted as to thickness and age. The deepest strata, south along the strike, is the Eocene, at 50 m depth off St. Catherines island. The age for its lowest member is 54.5 million years ago (Huddleston 1988). Henry includes upper Eocene member(s), which dates to 37 million years ago. Only those outcrops at or near the shelf break are designated as Miocene, 23.8–5.32 million years ago. Henry indicates middle Miocene units in light blue and early Miocene strata in dark blue. He does not map late Miocene strata on the inner-to-mid shelf below Sapelo Island's latitude (Henry n.d.).

Weems and Edwards (2001) show that Quaternary/Pliocene strata below the Sapelo Island to Cumberland Island portion of the Georgia Bight are over 40 m thick. Miocene age strata thicken to over 60 m in cores. Not shown, but described in areas located at the shelf edge (-100 m) beyond the Miocene age outcrops of the Savannah Scarp, are mud-bottom sediments deposited by shelf bypass mechanisms. These were deposited during the LGM lowstand and subsequent post-LGM transgression. The picture in the South Carolina portion is similar to that of the

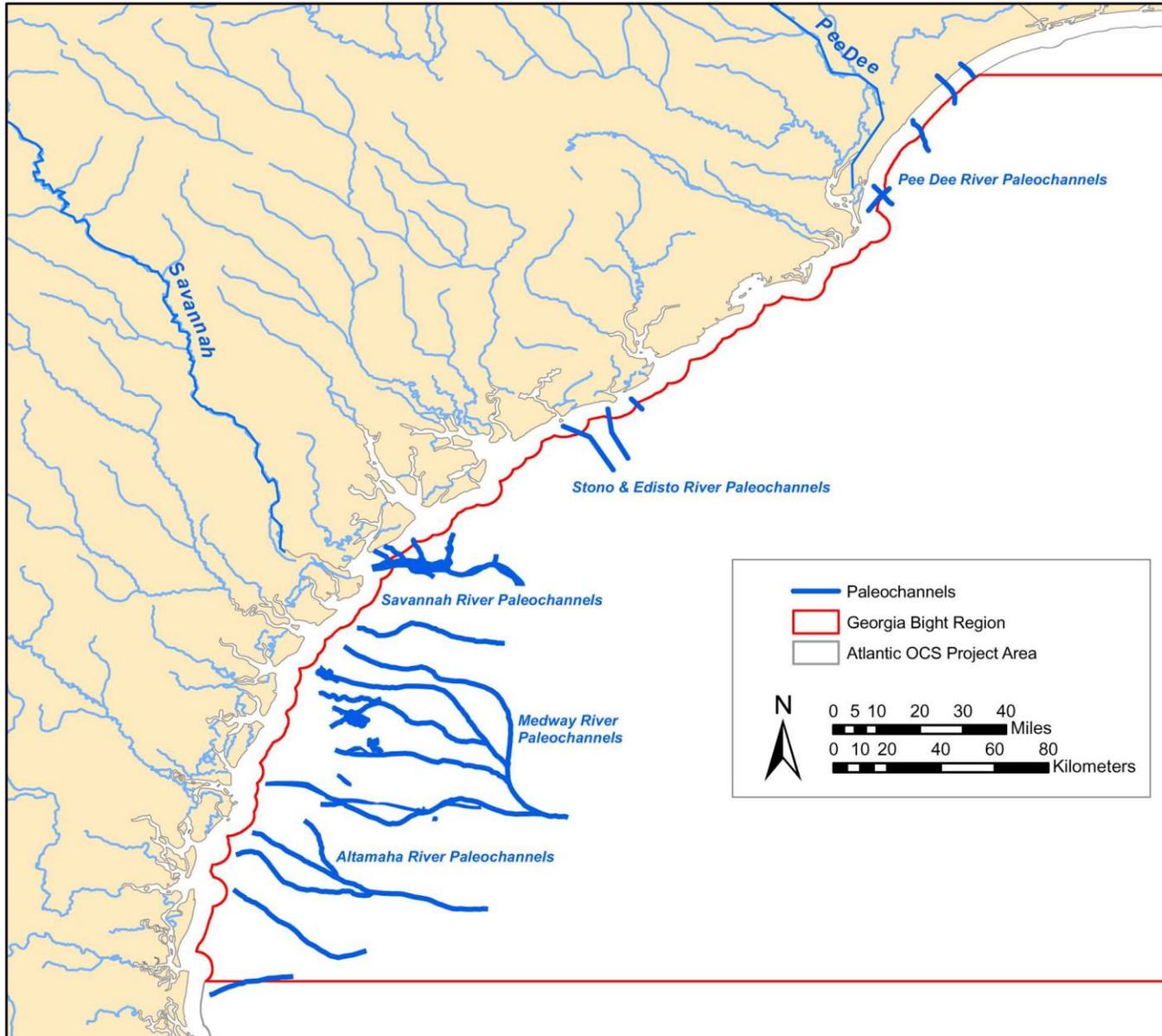


Figure 7.5. Model showing location of paleochannels within the Georgia Bight.

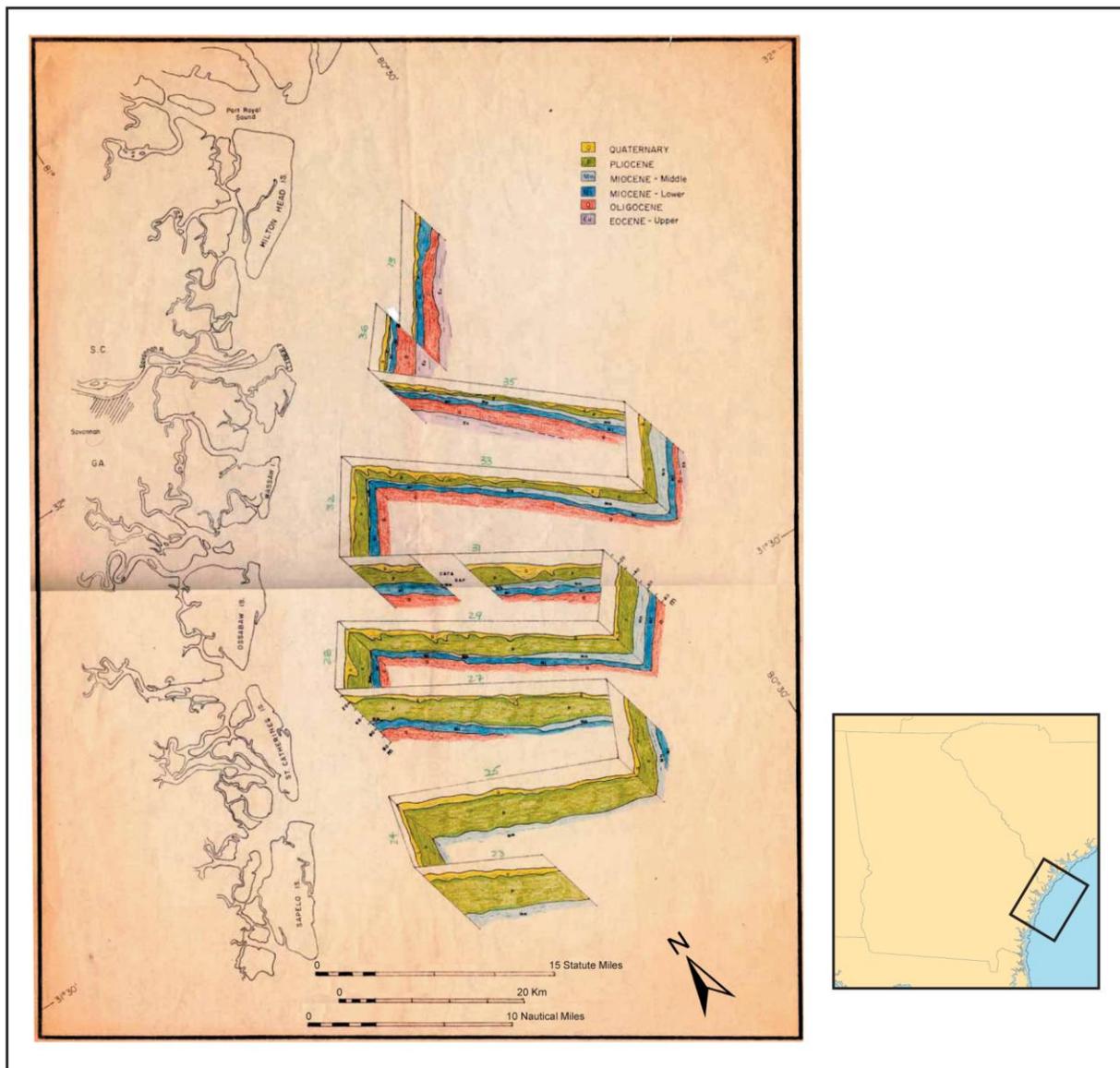


Figure 7.6. Seismic data for the inner-to-mid shelf north of Sapelo Island, Georgia, to Hilton Head Island, South Carolina (Henry n.d.).

Georgia section—southeast draining rivers have incised into these upper Cenozoic units creating paleo-valleys that have subsequently backfilled during cyclic changes in sea level, with a host of sediment types ranging from estuarine muds to clean shelly sands (Harris et al. 2005). In our site models, a higher probability for intact prehistoric sites is postulated for these valleys and river channels as opposed to the more readily eroded uplands and coastal plains.

Generally, the Georgia Bight is dominated by Cenozoic age strata, which represent basin edge sediments eroded and transported from inland terrains by Piedmont and Blue Ridge streams. However, when considering the implications of Georgia Bight geology for archaeological site preservation, the potential for sites is directly related to the presence or absence of more recent Quaternary age strata. Quaternary age strata are significantly eroded or

absent in the northern portion of the Georgia Bight as well as seaward of the Savannah River, where University of Georgia scientists found shallow Quaternary sediments in an unconformable relationship to Miocene strata during vibracoring in 2004 (Wendy Weaver, personal communication, 2005). South of the Paleo-Savannah Valley, Quaternary strata thicken and extend from beneath the coastal barrier system seaward to the middle shelf where, at Gray's Reef National Marine Sanctuary, they thin to a few meters thickness over Pliocene strata outcropping along the 20 m isobath. Northward toward the Cape Fear Arch these sediments thin rather than thicken.

Erosion of Quaternary strata, principally the Satilla Formation off Georgia, has left unconsolidated, time-transgressive sediment deposits that contain significant numbers of sub-fossil and fossil faunal remains of terrestrial mammals, notably bison, mammoth and horse. Nearshore, such as Edisto Beach, South Carolina, extensive paleontological remains have been found as well. Few readily identifiable prehistoric artifacts have been located in these sediments, but those that have putatively date to the Archaic period (Garrison in preparation). The lithic finds (2) are made from orthoquartzite, a rock type not found in local outcrops at this writing.

7.2. RELATIVE SEA LEVEL RISE

Paleoshoreline locations for the Georgia Bight are based on current relative sea level (RSL) curves, notably those of Chappell (2002), Cutler et al. (2003), and Siddall et al. (2003, 2008). In the Pleistocene/Quaternary, defined as 2.588 million years ago to 10,000 B.P., the Georgia Bight experienced 10 glacio-eustatic events (Foyle and Henry 2004:73).

Relative sea level studies have benefited from extensive research in the late 20th–early 21st centuries. The stimulus for the volume of studies has been paleoclimate research. Advances in dating techniques that include AMS radiocarbon, OSL and U-Th methods have allowed more accurate direct dating of sediments and sediment inclusions as well as corals. Coupled with more refined ages for the Marine Isotope Stages, based primarily on parts per thousand (per mil) variation in stable oxygen isotopes, well-dated proxy records have been developed for RSL for the last glacial period (Balsillie and Donoghue 2004; Bard et al. 1990a, 1990b, 1996; Blum et al. 2001; Gallup et al. 1994; Lambeck and Chappell 2001; Milliman et al. 1972; Otvos 2004; Shackleton 1987; Siddall et al. 2003, 2008; Sirocko 2003). Perhaps most informative to this region are the results of OSL studies of coastal deposits in North Carolina and east Florida (Burdette et al. 2009; Mallinson et al. 2008), bracketing the Georgia Bight with well-constrained ages for Quaternary RSL.

7.3. MARINE TRANSGRESSION AND SITE PRESERVATION

Underwater archaeological research in the Gulf of Mexico has targeted drowned river systems and their fluvial landforms as locations for intact archaeological sites (e.g., Dunbar 1988; Dunbar et al. 1989; Faught 2004; Faught and Donoghue 1997; Faught et al. 1992; Gagliano et al. 1984; Pearson et al. 2008). Faught (2004) and Pearson et al. (2008) each found *in situ* subaerial sediments on which the archaeological facies were located. However, unlike the Gulf, preservation of surficial Quaternary sediments and soils on the continental shelf is made difficult by the dynamic current regimes found there.

Significant portions of the mid-to-outer shelf of the Georgia Bight are covered with a relatively thin (1–2 m) veneer of Quaternary aged sandy sediments (Harris et al. 2005; Markewich et al. 1992; Pilkey et al. 1981). On the inner shelf, more evidence of cohesive mud and rock has been found in the shallow subsurface (Pilkey et al. 1981; Riggs et al. 1996; Toscano and York 1992), but much of this shelf is hardbottom. This general characterization can be made for the Georgia Bight from Florida to the Cape Fear Arch at the juncture of South and North Carolina. Indeed, one can extend the description to the Middle Atlantic Bight as well (Riggs et al. 1996).

Paleoshorelines are geological markers of stillstands in sea level. While their broad scale use for the Southeast (Cooke 1936, 1939) was called into question by Winker and Howard (1977), they have continued to be used on a local and sub-regional scale (Donoghue and Tanner 1992; Huddleston 1988). In most instances these shorelines are raised marine terraces (Colquhoun and Brooks 1986). In north Florida, Georgia, and South Carolina, up to seven Quaternary shoreface systems are identified, although their identification as the same geologic unit, across these three states, is not consistent. For instance, Adams et al. (2010) identify only three paleoshorelines in their study of Pleistocene sea-level oscillation in northeastern Florida. In Georgia and South Carolina the nomenclature and dating of these paleoshorelines is more consistent. Like drowned streams and valleys, drowned shorelines can be locations of higher prehistoric site density, although the potential for such sites to survive transgression is very limited (e.g., Driver 2004; Stright et al. 1999).

Erosion, linked to sea level rise/fall—transgression/regression—in the Georgia Bight, has been observed and quantified by Alexander, working at Skidaway Island and neighboring Wassaw and Ossabaw Islands, where he has documented extensive coastal erosion of these modern barriers (Alexander and Henry 2007; Robinson et al. 2010). Likewise, other researchers writing of St. Catherines Island and neighboring Sapelo Island document extensive shoreline erosion and aggradation associated with these coastal barriers of the Georgia Bight (Bishop, Meyer, Vance, and Rich 2011; Booth et al. 1999; Chowns et al. 2008; Rich and Booth 2011). On Skidaway Island, Ossabaw Island and St. Catherines Island, this erosion has led to the documented loss of archaeological sites dating from the Late Archaic through Mississippian periods (Alexander and Henry 2007; Thomas 2008).

Not all areas along the Georgia Bight are eroding, most notably the upper portion of the Georgia coast. Alexander and Henry (2007) have dated aggrading west-to-east beach lines on Ossabaw Island approximately 1,400–1,820 years ago (see also Robinson et al. 2010). Rich and Booth (2011) have dated the Holocene aggradation of beach cheniers on the southern tip of St. Catherines Island. Concomitant with that aggradation, the mid-portion of that same island is experiencing significant erosion (Bishop, Rollings, and Thomas 2011; Thomas 2008). Barrier islands along the Grand Stand (Myrtle Beach) and Folly/Kiawah Islands (Charleston-Beaufort) show similar behavior.

Because the Georgia Bight is an active erosional geomorphic surface, particularly the Inner-to-Mid shelf areas, one cannot expect significant preservation of prehistoric archaeological sites at or near the modern seafloor. At two localities in the Georgia Bight, Garrison et al. (2008, in press) report artifact and faunal remains that are time-transgressive, in that Holocene-aged sub-

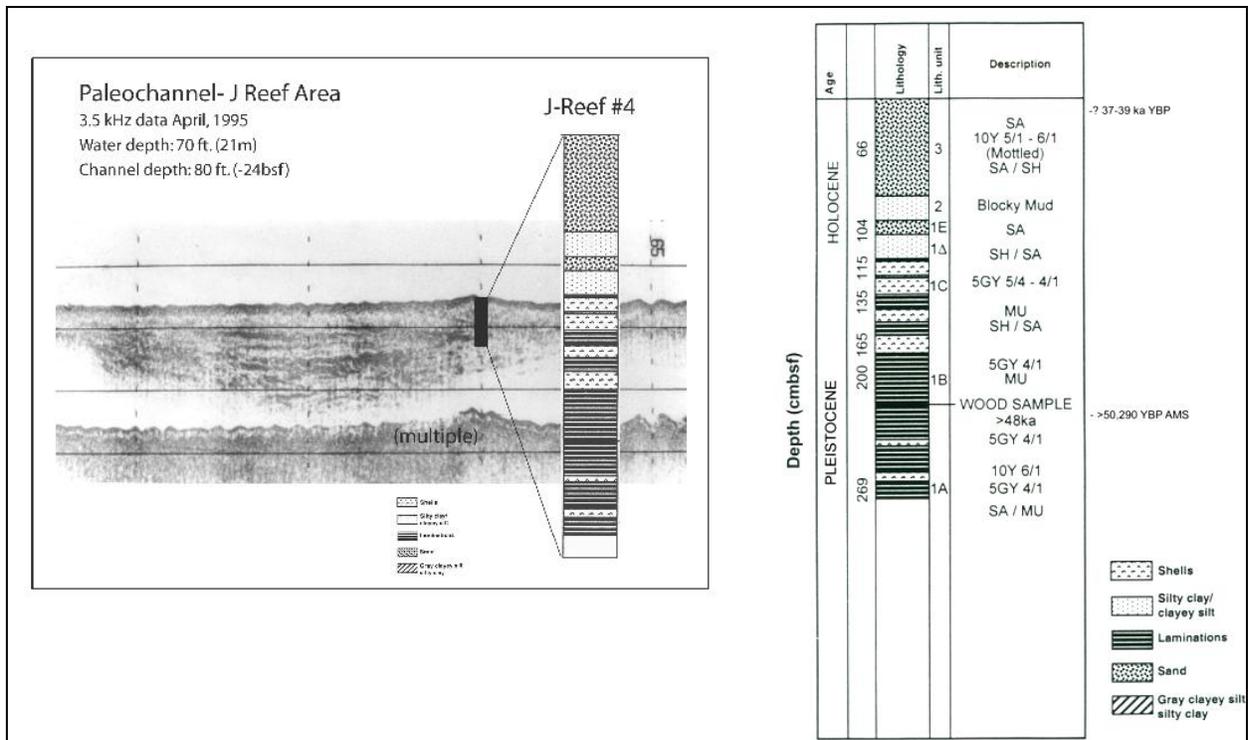


Figure 7.7. Profile of sediment core placed into a paleochannel in the Georgia Bight showing estuarine/fluvial sediments below the transgressive sand sediments.

fossils are found directly in association with Late Pleistocene (ca. 40,000 B.P.) materials. *In situ* mixing of seafloor sediments has been observed over a two-year study span.

Paleo-stream channels are not readily observed on the Georgia Bight except in seismic records. Studies by Garrison et al. (2008) and others (Baldwin et al. 2006; Harris et al. 2005) indicate that these paleo-streams are buried, albeit shallowly, under the reworked shelf sediments. Sediment cores into one of these paleochannels show estuarine/fluvial sediments below the transgressive sand sediments (Figure 7.7). Dating attempts on these more intact sediments, which are more likely to preserve *in situ* archaeological materials, failed to obtain ages that were prior to 27,000 B.P. (Garrison et al. 2008:Table 3). Stubbs et al. (2007) reported a river channel on the Middle Shelf of the South Carolina portion of the South Atlantic Bight. Its paleovalley walls showed some slight relief in contrast to that of the Paleo-Medway River, where a sediment core was obtained in 1996 (Littman 2000). This paleostream, named the Transect River, is part of the several paleoincisions of the paleo-North Edisto and Stono rivers that are mapped off Folly and Kiawah islands (Harris et al. 2005).

Based on existing data from a battery of late 20th- and early 21st-century studies, a great deal is known about sea level rise and fall and the mechanisms for its variation. Likewise, there exist extensive data on the nature of sea floor erosion and its role in shaping the geomorphology of the continental shelf. Modern geological models such as that of sequence stratigraphy provide a robust conceptual framework for assessing the likelihood for the preservation of prehistoric archaeological sites. However, there does not exist a similar wealth of data on the presence/absence or distribution of prehistoric sites on the continental shelf of Georgia and South

Carolina. It is possible that the potential for preserved archaeological deposits is greater on the nearshore or inner shelf of the Georgia Bight, where sediments are somewhat thicker than those of the mid-shelf. However, assessing this potential will await direct archaeological evidence.

Paleochannels provide the best geological feature for investigating potentially preserved submerged sites, since sites located adjacent to rivers have the best chance of having been buried prior to inundation. In the absence of such pre-inundation burial, archaeological sites have little to no potential to survive transgression. Paleochannels were plotted for this study using a synthesis of existing data, including technical reports, unpublished data housed at the Georgia Southern University's Applied Coastal Research Laboratory, and personal communication with researchers known to have unpublished data (e.g., Alexander and Robinson 2006; Foley 1981; Foyle et al. 2001; Garrison n.d.; Henry n.d.; Henry et al. 1978; Henry and Idris 1992; Hill n.d.; Kellam and Henry 1986; Swift et al. 1972b). These sources were used to identify and map surface and subsurface expressions of Quaternary paleochannels on/in the continental shelf of study region. Maps and report figures were scanned and georeferenced, and existing shapefiles were obtained to build the database. Shapefiles in this project (provided under separate cover) are named according to the data source used for each layer's construction and include: research cruise tracklines, sub-surface areas of interest, and crossings of buried paleochannels and proposed paleochannel pathways.

Paleochannels in the Georgia Bight are known with some certainty, having been derived from recent geophysical data. Such paleochannels include the Paleo-Savannah, the Paleo-Altamaha, the Paleo-Medway rivers off the coast of the Georgia, and the Paleo-North Edisto/Stono and the Paleo-Pee Dee systems off the South Carolina coast (Baldwin et al. 2006 Harris et al. 2005). The other paleo-channels plotted in Figure 7.5 above and Figures 7.8–7.9 below have been inferred by earlier workers such as Swift (1976), using indirect evidence such as bathymetry. Areas adjacent to these paleochannels have the best potential for burial of sites while the areas were subaerial, and therefore the best preservation potential. Wave action is also a heavily destructive factor, and sites will better survive in a buried context if they exist below the wave base. Rapid sea level rise may ameliorate the intensity of this destructive force and allow for sites buried while the region was subaerial to survive transgression.

7.4. ARCHAEOLOGICAL SENSITIVITY AND PRESERVATION POTENTIAL

As noted in Section 7.2, there are no region-specific sea level curves defined for the Georgia Bight, and general eustatic curves have been used, bracketed by RSL curves further north and south of the region. Based on these data, archaeological sensitivity is defined as follows:

- **No Sensitivity.** Areas 110 m and greater in depth are considered to be areas with No Sensitivity for prehistoric sites, since these areas were not subaerial during the LGM.
- **Low Sensitivity.** Areas from the 110 m to 70 m isobaths. This designation covers areas exposed between the time of the LGM and the earliest Clovis occupation, ca. 13,000 B.P.
- **High Sensitivity.** High Sensitivity areas include all areas within the OCS that are shallower than 70 m.

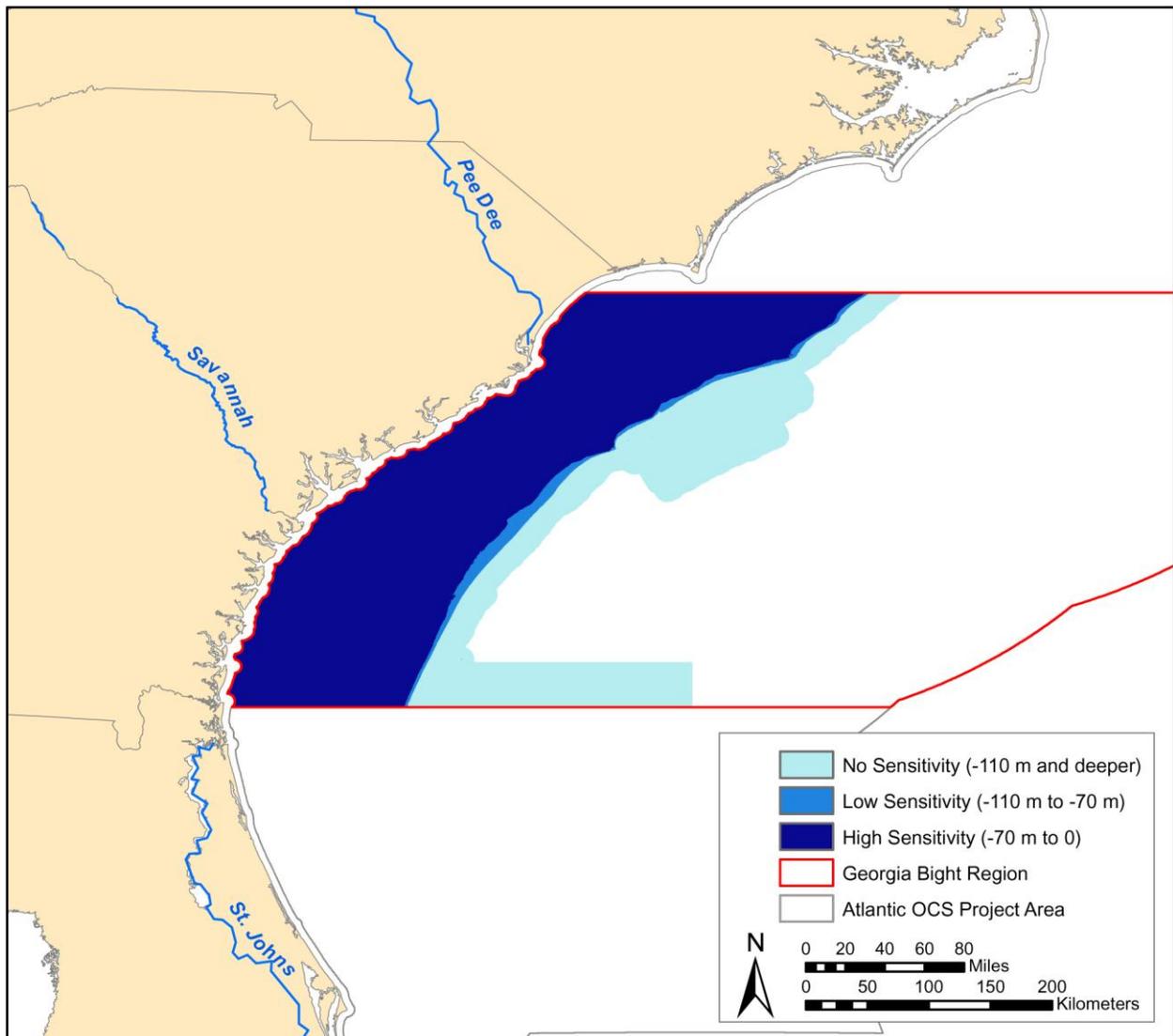


Figure 7.8. Archaeological Sensitivity map for the Georgia Bight study region.

Figure 7.8 illustrates the sensitivity areas for the Georgia Bight study region. As indicated above, sea levels during the LGM in the Georgia Bight regressed to the edge of the Continental Slope at or below -110 m, so depths greater than 110 m have no potential for containing prehistoric sites. Low Sensitivity areas encompass portions of the OCS that were subaerial between the LGM and the beginning of the Paleoindian period, or ca. 20,000–13,000 B.P. Sea level curves place the beginning of the Paleoindian period at approximately -70 m. High Sensitivity areas for the Georgia Bight region range from -70 m to the 3-mile federal/state boundary.

Other than landforms along paleochannels that may have been occupied and buried in sediment prior to transgression, areas of High Preservation Potential are difficult to identify in the Georgia Bight. Some areas, such as hardbottoms located in the vicinity of paleochannels, have particular value for identifying archaeological materials, simply because of the lack of

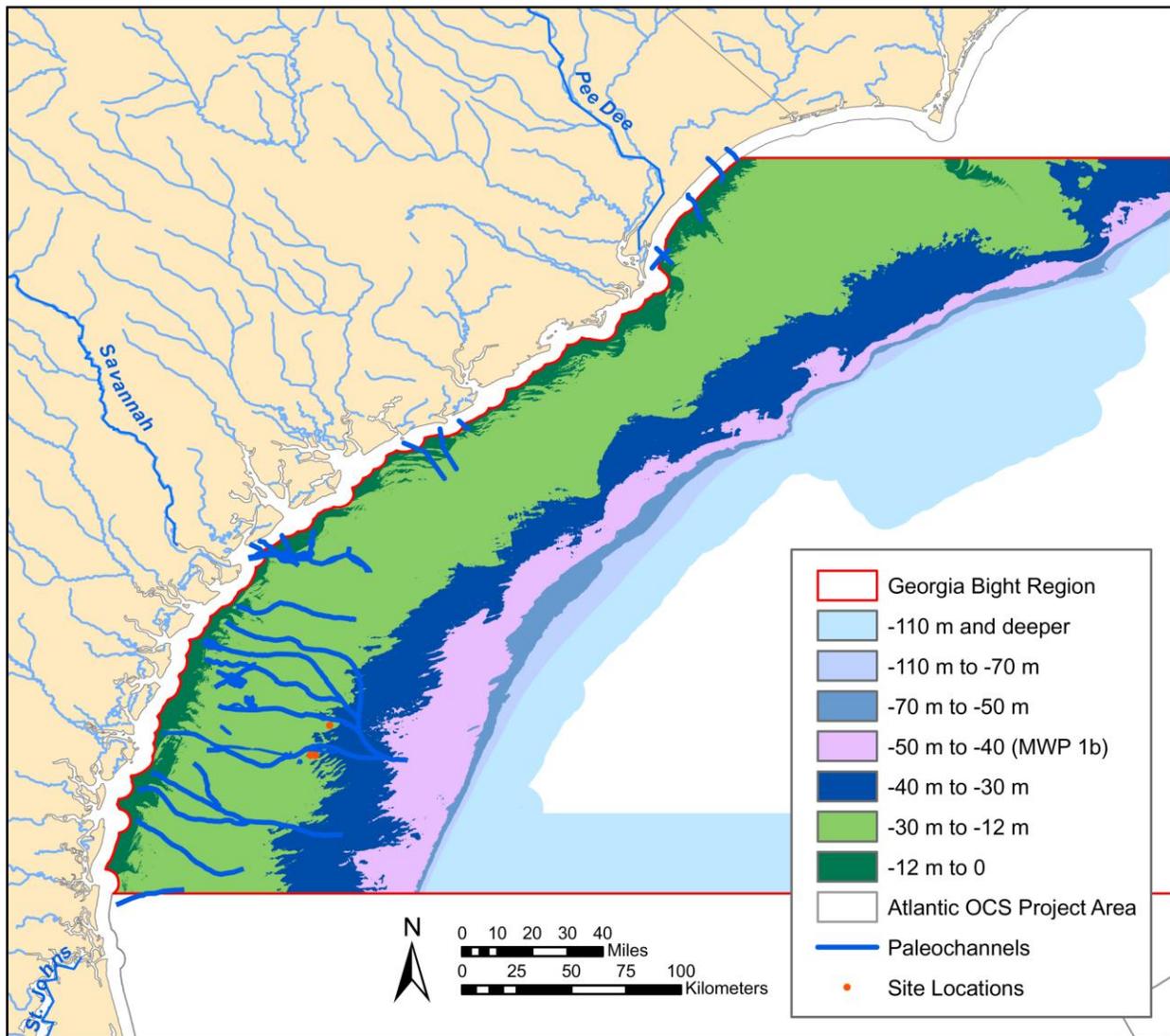


Figure 7.9. Sea levels for specified periods, including High Potential area corresponding to MWP 1b in the Georgia Bight study region.

sediments, but the seafloor surface in these locations provides little potential for intact sites, given the scouring effects of bottom currents. As with the Middle Atlantic, it is postulated that the rapid sea level rise associated with MWP 1b may have enhanced the preservation potential of previously buried sites, so that region is represented in Figure 7.9 as an area with high preservation potential.

8. FLORIDA

8.1. REGIONAL GEOLOGY

The Florida Platform extends southward from the North American continent and separates the Atlantic Ocean from the Gulf of Mexico (Figure 8.1). Since its formation, it has been alternately flooded by shallow seas and salt lakes or has been sub-aerially exposed (Schmidt 1997). The Florida peninsula represents the exposed portion of the platform, and the remainder extends offshore well into the Gulf of Mexico and, for a short distance, into the Atlantic Ocean. Contemporary depths of the ocean floor around Florida are shown in Figure 8.2. The tectonic stability, porous limestone bedrock, and thin sediment cover of the Florida Platform during the last 15,000 years provide an ideal physical environment for the reconstruction of paleoshorelines (Lidz and Shinn 1991). As early as 1966, Emery and Edwards (1966) identified the possibility that prehistoric peoples inhabited the now-inundated Atlantic continental shelf of Florida.

Continental shelves around the world are remarkably dynamic, thus recreating past submerged landscapes has been an adopted goal of archaeological, geological, and geomorphological researchers. The intent of this chapter is to assess the past and present geologic and physiographic changes within the study area as global sea levels rose since the LGM, ca. 20,000 B.P. Understanding the evolution of the shelf and coastal geomorphic features provides insight into the potential preservation and destruction of submerged prehistoric sites.

The modern Florida Atlantic continental shelf is a wave-dominated, low gradient feature with a well-defined shelf/slope break. Tidal range and wave energy flux decrease within the shelf's southern portion. The modern sedimentary cover is dominated by quartz within the northern portion, and is more carbonate-enriched to the south, while the inner shelf topography is characterized by shoreface sand ridges on the north and relict reefs on the south (Hine 1997). The shelf width throughout the study area varies greatly from 115 km off Jacksonville to 2 km off southern Palm Beach County.

Generally, a thin band of Holocene sediments forms the present coastline of the state, and these deposits consist of beach, dune, marsh, and lagoon sediments that developed in response to the latest rise in sea level (Hine 1997). The Holocene sediments are comprised of clastic, carbonate, and organic sediments.

During a previous study of the current project area (SAI 1981), two geomorphic provinces (the North/Central Florida Shelf and Southern Florida Shelf north of the Keys) were identified for the Florida Atlantic continental shelf based on wave climate, tidal range, and sediment deposition. For the purposes of the current study, these two geomorphic provinces are maintained.

The North/Central Florida Shelf consists of the portion of the shelf from the St. Johns River to West Palm Beach. This geomorphic province represents a transition from the estuarine retreat blanket of the Georgia Bight (southern South Carolina to northern Florida) and the mixed carbonate/clastic depositional regime to the south (SAI 1981). The most common sediment in this province is a fine to medium-grained, moderately sorted to well-sorted quartz sand having

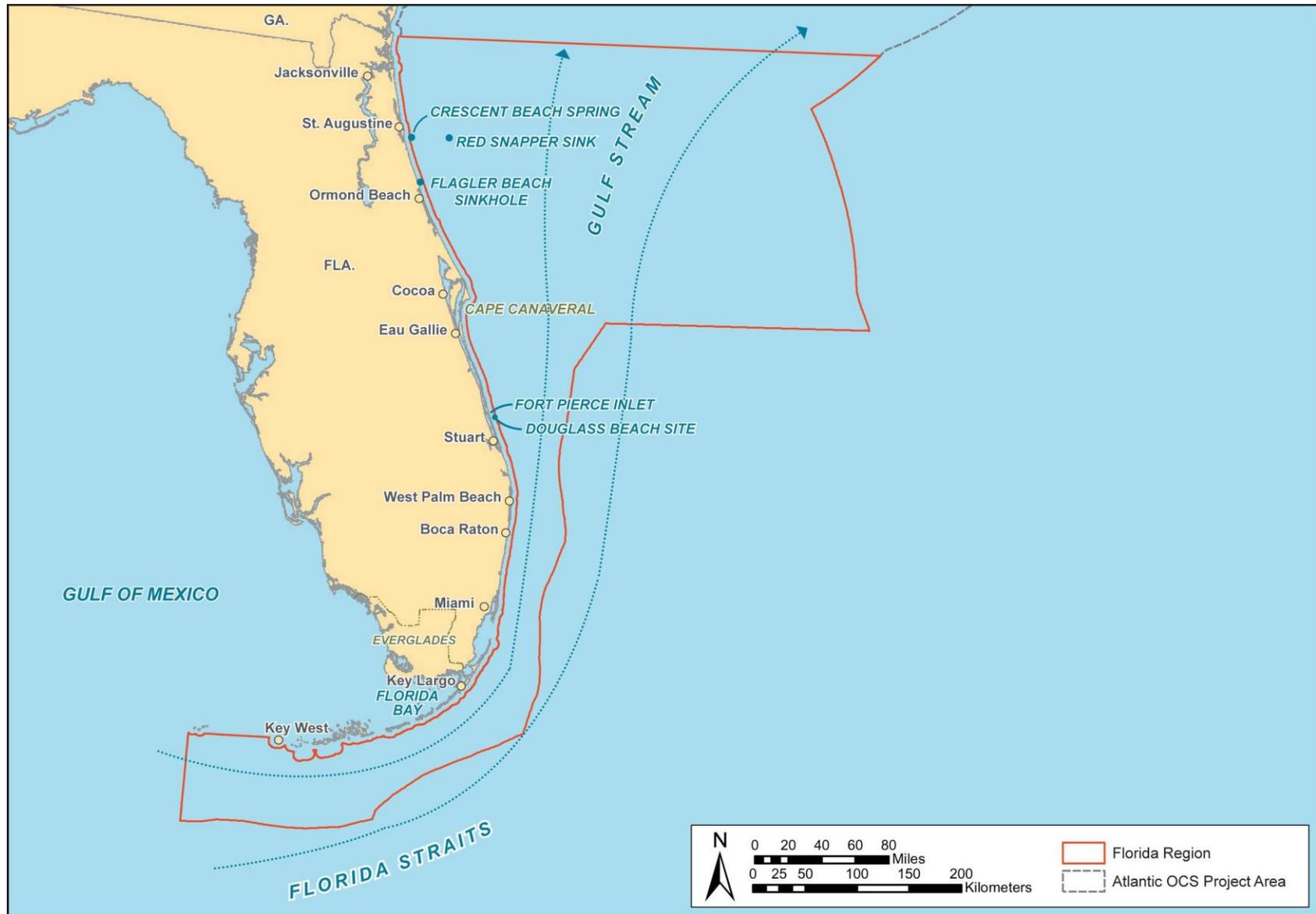


Figure 8.1. Project area along the Florida coast.

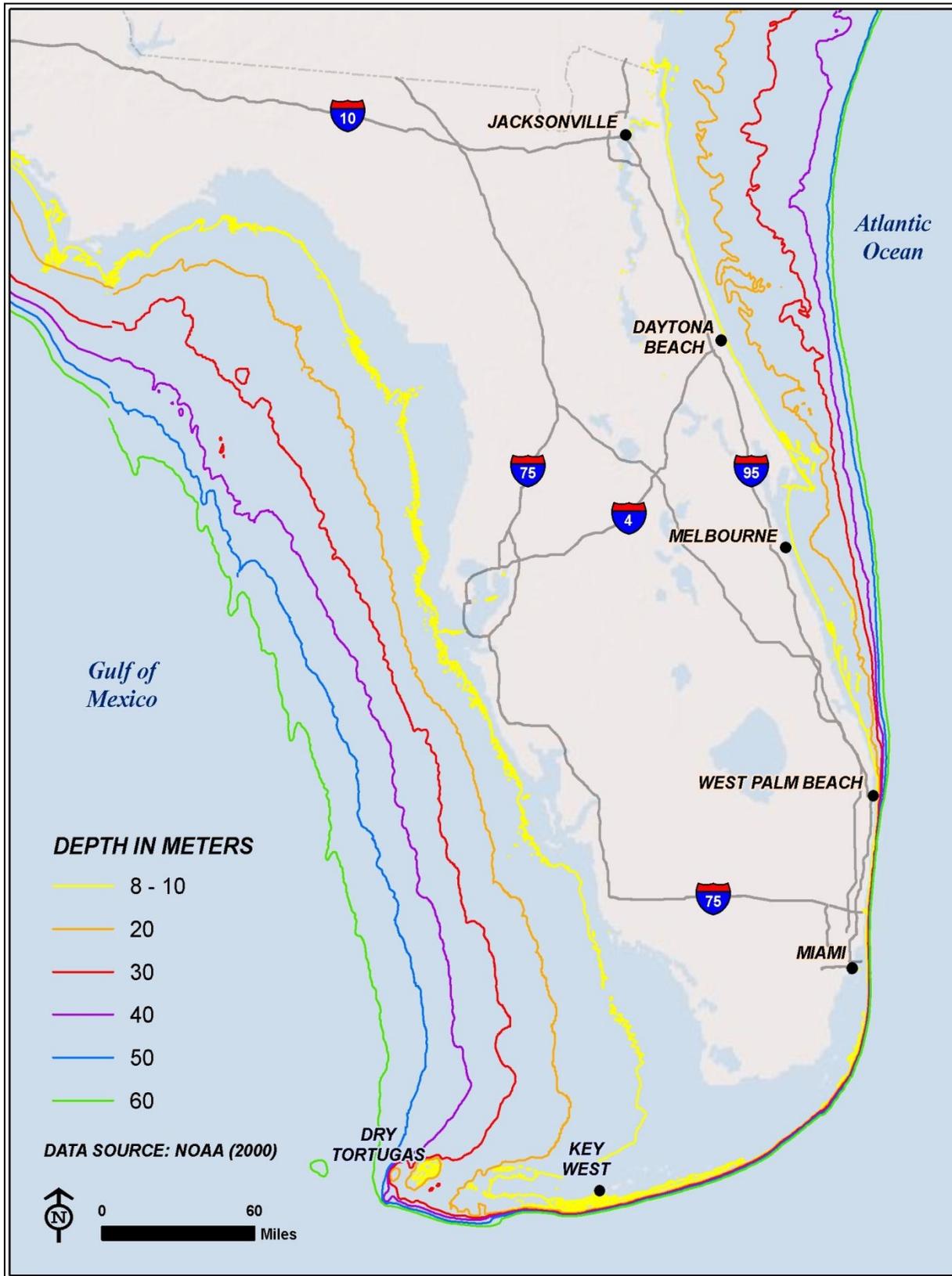


Figure 8.2. Offshore depths around Florida's coastline today.

15 percent carbonate that consists of mostly bivalve fragments (Meisburger and Field 1975). From Jacksonville to West Palm Beach, lithified beach deposits of the Anastasia Formation are sporadically exposed. Major outcrops of the Anastasia Formation occur on the east coast of Florida from St. Augustine to Ormond Beach, Cocoa to Eau Gallie, and Stuart to Boca Raton (Lovejoy 1998).

The Anastasia Formation is a multi-cyclic deposit formed during former transgressions of the sea (Scott 1997). Perkins (1977) recognized at least two disconformities within the Anastasia Formation, and Osmond et al. (1970) measured two different ages for the formation, suggesting two episodes of accumulation. At the time the Anastasia was deposited, 130,000–100,000 B.P., the earth was experiencing an interglacial, and sea level was approximately 6 m higher than that of today (Lovejoy 1998). For example, Perkins (1977) points out that most of Martin and Palm Beach counties were inundated, which would account for shells found inland as well as the low hills that represent old barrier/beach dune deposits.

When the last glacial reached its apogee about 20,000 B.P., the glaciers began to melt, temperatures rose, and sea level began to rise. As sea level rose to its present height, outcrops of the Anastasia Formation underwent wave erosion in the surf zone (Lovejoy 1998). The outcrops that still remain formed offshore reefs consisting of bedrock ledges with varying amounts of living and dead coral, and are separated by intervals of barren, sandy bottom. The outcrops are found at successively deeper intervals down to depths of 33 m and extending 1.6 km out from the shore near Palm Beach Inlet, and up to as much as 5 km north of the inlet (Lovejoy 1998).

The Anastasia lithology varies from coarse rock to sand, and shelly marl to sandy limestone, with mollusks. Originally the Anastasia Formation was applied to only coquina rock, but it now includes all Pleistocene marine deposits, and is estimated to be approximately 30 m thick (Murphy 1990). The Anastasia Formation grades into Miami Limestone in southern Palm Beach County.

Within the North/Central Florida Shelf, Holocene cover is generally thin to absent. Moreover, the Quaternary section is seldom thicker than 5 m, except beneath the linear or cape associated shoals such as Cape Canaveral. In addition, there are no major sources of fluvial sediment south of the St. Johns River. As a result, all terrigenous sands, including quartz, feldspar, and other heavy minerals are derived from the Georgia Bight by southerly long-shore transport. Consequently, reworking of tertiary rocks is probably an important sediment source during sea level fluctuations, as is the production of biogenic sands, particularly in the south.

Dominant topographic features within this shelf province include the Cape Canaveral cusped foreland and its associated offshore bathymetry. In this area, the shelf supports a complex bathymetric variety of attached and isolated linear shoals, broad depressions and highs, as well as one cape retreat massif off Cape Canaveral and one off False Cape (Hine 1997). According to Swift et al. (1972a), cape retreat massifs form on shelves as cusped forelands that migrate landward in response to sea level rise. Maximum Holocene thickness on the shelf within this province is 12 m and is located beneath the Cape Canaveral retreat massif. Peats obtained by vibracoring strongly suggest that back-barrier environments are preserved within the shelf stratigraphic section in this area (SAI 1981). Radiocarbon dates from peats show Holocene and

Late Pleistocene ages, which would be contemporaneous with early populations if they existed here. As such, there is a high potential for preserved sites or artifacts in the Cape Canaveral area.

The Southern Florida Shelf north of the Keys consists of the portion of the shelf extending from Palm Beach County to Key West. It is a narrow section consisting of four shelf environments: sand flats and karst; sand flats and coral reefs; sand flats, hardgrounds, and coral reefs; and tidal sand flats and ridges, hardgrounds, and coral reefs (Finkl and Andrews 2008).

Perkins (1977) traced the evolution of the southern Florida Platform from an area dominated by quartz sands mixed with carbonate sediments during the Early Pleistocene to a carbonate-dominated environment during the Late Pleistocene. The Late Pleistocene carbonates include the Miami and Key Largo Limestone. The Miami Limestone consists of two facies: an oolitic limestone that underlies the Atlantic Coastal Ridge south of Boca Raton and a bryozoans-rich limestone that underlies the Everglades and Bay of Florida (Scott 1997). The Paleoreef trend in the Florida Keys is preserved in the Key Largo Limestone.

The seaward limit of the southern province is a relict Holocene reef line that lies in approximately 15–25 m of water (SAI 1981). The rock ridge and terrace couplets are progressively steeper in the seaward direction and support a modern benthic community of alcyonarians, sponges, and scattered coral heads (Lighty et al. 1978). The rock ridges were *Acropora palmate* (coral)-dominated barrier reefs that flourished during the Late Holocene, and radiocarbon dating indicates that these reef tracts terminated approximately 7000 B.P. (Lighty et al. 1978). Lighty et al. (1978) have postulated that exposed soil horizons were eroded as sea level rose, creating turbidity levels high enough to stress the reef community. In addition, broad lagoons formed behind the reefs, and the flow of cold water over the reef during the winter also contributed to reef demise.

Surface sediments on the Southern Florida Shelf north of the Keys include *Halimeda*, mollusks, benthic foraminifers, bryozoans, and corals. Active sabellariid worm reefs and their debris are common near the shoreface within water depths ranging from 3–10 m. There are also nonskeletal carbonate components, including pellets and ooids. The southern province is considered more tropical than that to the north, and the two provinces contain distinct assemblages. For instance, the *Halimeda* and coral are not present in the northern province, and mollusks and barnacles are not present in the southern province (Hine 1997).

In situ carbonate skeletal sands have accumulated up to 5 m in the topographic lows between the reefs. These areas presumably have high preservation potential for cultural resources, as little sediment exchange occurs between the mixed terrigenous/carbonate sands of the beach zone and the offshore carbonate sands.

The shelf seaward of the Keys may be considered a subprovince of the Southern Florida Shelf North of the Keys (SAI 1981). The Keys are a chain of Pleistocene reef and oolitic-limestone islands that extend from Miami to Key West, separating Florida Bay from the Florida Straits (Randazzo and Halley 1997).

The two primary surficial stratigraphic units of the Florida Keys are Key Largo and Miami Limestone. The Upper Keys are generally reefs of the Key Largo Limestone and are oriented

parallel to the shelf edge. The Lower Keys are elongated and perpendicular to the shelf and are composed of oolite of the Miami limestone.

Seaward of the Keys, the shelf consists of intermittent living and dead linear and patch reefs, barren rubble flats and mounds, and belts of thin, mobile sand bodies. The slope seaward of the shelf edge reef track drops off steeply in the Florida Straits.

The ancient reefs that fossilized in the Keys and the surrounding subsurface flourished between about 145,000–90,000 B.P. (Randazzo and Halley 1997), at which time sea level was 6–8 m higher and the reef system extended to the Gulf Stream. Lacking *Acropora palmata*, the present-day Florida Keys include a series of coalescing patch reefs. These reefs grew on the preexisting topographic relief on an otherwise open shelf (Harrison and Coniglio 1985). According to Shinn et al. (1989) there is a zone of older, dead reefs near the outer shelf margin. These dead reefs are suspected to represent multiple reef tracts and may be of Pleistocene age.

Shinn et al. (1989) have outlined the control of reef distribution by eustatic sea level changes and topography. A sea level fall that began approximately 100,000 B.P. is believed to be responsible for the eventual distribution of a large part of the Pleistocene coral reef system and exposure of the Florida Keys. Sea level may have fallen more than 100 m, and during this exposure, laminated calcareous crusts formed (Mutler and Hoffmeister 1968). The exposure surface formed the substrate colonized by more recent corals when sea level began to rise about 18,000 B.P., eventually flooding the South Florida Shelf. Peat deposits formed in bogs and ¹⁴C dating of these materials have helped to recognize geologic events over the last 10,000 years (Robbin and Stipp 1979). Sea level has steadily risen over the past 15,000 years, which has renewed cross-shelf water interchanges between the Gulf of Mexico and the Atlantic Ocean. The combination of higher salinity during the summer and colder temperatures in the winter would greatly inhibit the ability of reef building corals to recolonize, especially *Acropora palmate* (Randazzo and Halley 1997).

Localized coral reef colonization appears to be controlled by topographic conditions that provided substrate highs, and coral debris distributed on the landward side of reefs provides the hard substrate required for reef colonization during periods of sea level rise. Moreover, ecologic zones have expanded upward and landward in response to sea level rise. The Caribbean reef crest *Acropora palmata* forms buttresses (or trough-like grooves) on the seaward edge of the best developed Keys reefs (Shinn 1963).

Wave and current action, along with preferential coral growth on the spurs, serve to accentuate the configuration of the reef structure (Randazzo and Halley 1997); however, settlement of coral larvae is prevented by the sedimentological processes in the grooves (Shinn 1988). The reef platform is comprised of fore-reef, reef tract, and back-reef zones (Randazzo and Halley 1997), and core-boring transects across reefs (Shinn et al. 1989) show that modern reefs have formed on the topographic relief provided by Pleistocene reefs. Reefs have not built seaward, but have grown in place or migrated landward a short distance (about 100 m) over their back reef sand and rubble deposits.

The potential for preservation of sites on this subaerially exposed pre-Holocene surface would be high. As the seaward reefs build up, the back reef areas become flooded by low-energy

lagoonal waters. Further, carbonate-producing organisms generate sediment, which would slowly bury man-made artifacts or sites. Since most wave energy is expended on the shelf edge reef, it would be unlikely that the lagoonal sedimentary sequence would be disturbed to any significant depth by high energy events.

In terms of drainage systems, the peninsula of Florida is characterized by north-to-south orientation of rivers that reflects the nearshore environment, which contributed to its basic landform construction (Schmidt 1997). During past sea level high stands, relict beach ridges were constructed, and these ridges are separated by swales that were previously occupied by shallow lagoons (Schmidt 1997). When sea level dropped, these lagoons became valleys, and streams eroded the sands and clays, creating several coast parallel river systems (Schmidt 1997).

The only major stream or river flowing into the project area is the St. Johns. Although it is extensive and broad, the St. Johns River has a very low discharge rate, averaging 8,300 cubic feet per second. This discharge is related primarily to volume and less to velocity, as the river has a wide floodplain and low gradient (0.02 m per km) (Miller 1998). For most of its length, the St. Johns River does not exceed 1.5 m above mean sea level. The low gradient makes the river susceptible to small changes in sea level, and even today the river is tidally influenced as far south as the Wekiva River, approximately 120 miles from the river’s mouth. Given the lack of major streams or rivers aside from the St. Johns River within the project area, the terrigenous sediments along Florida’s shelf have been carried from the north by longshore transport, and the calcareous sediments that exist have been generated *in situ*.

8.2. RELATIVE SEA LEVEL RISE

While focused on the Gulf of Mexico side of Florida, the recent work by Balsillie and Donoghue (2004) combines all relevant classes of data in the area immediately adjacent to the Floridian Atlantic Continental Shelf, with particular reliance on directly dated features. Representative sea levels based on their analysis are presented in Table 8.1. Balsillie and Donoghue’s (2004) data correlate well with other late Quaternary sea-level estimates, in particular a eustatic index based on data sets acquired from the Red Sea (Siddall et al. 2003). They suggest that the Gulf’s relatively low-energy environment and geological stability offer a —near-eustatic sea-level” curve with global application. The authors contend that the mid- to late-Holocene high-stands in the Gulf provide what is arguably the best example of eustatic sea level change worldwide.

Table 8.1. Florida Sea Level Curves (based on Balsillie and Donoghue 2004).

Time Period (years B.P.)	Meters Below Present Sea Level
6000	2
8000	10
10,000	25
12,000	40
14,000	80
16,000	100
18,000	110
20,000	120

Using valid in-place sea level indicators (marine peats and intertidal oyster shell beneath the sea floor) south of Cape Hatteras, Blackwelder et al. (1979) also refined the Milliman and Emery (1968) curve. The result was a shallower curve (30 m) for the Southeast Atlantic shelf (Weaver 2002). Their curve indicates that at 17,000 B.P. the sea stood 60 m below its present level and that by 10,000 B.P. it rose to 22 m below the present level (Dunbar et al. 1992). These figures seem in line with the younger curve derived by Scholl et al. (1969), which is from a large, well-dated set of paired freshwater and tidal sediment samples from the Florida Keys. These data show a gradually decreasing rate of sea level rise at about 6000 B.P. (Dunbar et al. 1992).

Ongoing research in Florida combined with recent advances in our understanding of the Clovis time period indicate that the critical period from 13,100 to 12,800 calendar years before present may cover the entire period in which Clovis existed (Waters and Stafford 2007). During this brief Clovis florescence, sea level rose nearly 25 m, from roughly 75–50 m, which has profound implications for land use, resource distribution, and resource exploitation by Early Paleoindians (Balsillie and Donohue 2004).

Sea levels oscillate continuously, albeit some temporal periods have experienced more drastic climatic changes than others, resulting in rapid sea level fluctuations. Worldwide sea levels at the end of the LGM (approximately 20,000 B.P.) were 120–130 m lower than present-day levels, indicating that large portions of the continental shelf off Florida's coast were exposed. When Paleoindians arrived over 12,000 years ago, sea levels were approximately 40 m lower than present-day levels (Faught 2004:277), and in Florida the climate was cooler and drier, and water was in shorter supply at inland locations (Milanich 1994:40). A brief stadial of cooler temperatures referred to as the Younger Dryas is believed to have occurred between ca. 11,000 and 10,000 B.P., and during this interval, sea level rise stabilized; however, by about 10,000 B.P., increased temperatures led to accelerated glacial melting, thereby increasing the rate of sea level rise once again (Faught 2004:277). Sea levels continued to rise at a fairly rapid pace throughout the ensuing millennia, until conditions comparable to those of modern times occurred at about 5000 B.P. (DePratter and Howard 1977; Miller 1998:39; Randall and Sassaman 2005:17; Thomas 2008:42).

These sea level changes flooded areas along the continental shelf, greatly reducing the land mass there (Gannon 1996:2). As a consequence, numerous coastal prehistoric settlements were inundated (Marks 2006:xiii), which influenced human settlement (Faught 2004:277) and ritualistic behavior (Sassaman 2009). Once sea level changes stabilized, barrier islands began to form on the coasts, stream gradients became reduced and stabilized, vegetative complexes and associated fauna became essentially comparable to that of modern times, and surface waters became much more prevalent (Miller 1998:39; Thomas 2008:42). Although sea level largely stabilized by 5000 B.P, small-scale changes are documented in later times, including the period from about 3000–2500 B.P., when there is archaeological evidence for slightly lower sea stands (Ashley 2008; DePratter and Howard 1980; Russo 1992).

Sea level rises over the past 2,500 years in south Florida have an average rate of about 38.1 mm per century. However, since 1932 (when tide gauge monitoring stations were installed) south Florida has incurred a 22.86 cm relative rise in sea level. It has been postulated that this

accelerated rise is the result of warming (and expansion) of water in the western North Atlantic Ocean (Broward County Climate Change Task Force 2009).

8.3. MARINE TRANSGRESSION AND SITE PRESERVATION

The rate of sea level rise is important to the development of the Florida Atlantic coast. The spatial and temporal distribution of the archaeological record of coastally adapted cultures along the Atlantic coast of Florida must be understood in the context of the evolving coastal landscape.

Numerous investigators have shown that Holocene sea level rise has played a key role in the origin and development of the inner continental shelf seafloor and modern barrier island system (Dillon 1970; Field and Duane 1976; Hoyt 1967; Pierce and Colquhoun 1970; Swift 1975; Thomas 2008). Because shoreface retreat is the dominant transgressive process along the Florida Atlantic coast, the great majority of Paleoindian and Archaic period archaeological sites that were once on the continental shelf were likely destroyed during the Late Quaternary sea level rise if they were exposed to heavy wave action or storm surges for any length of time (Waters 1992).

Generally speaking, most of the Florida Atlantic continental shelf is low and sloping, and therefore would have been dominated by erosional transgression—particularly in the North/Central Florida Shelf. Such conditions would afford a low potential to preserve archaeological sites that may have existed. However, there are local settings within this region that would have experienced a depositional transgression, such as cape-associated shoals, nearshore linear shoals, the mainland side of lagoons, and along the banks of estuaries (SAI 1981:I-57, I-59). The carbonate-dominated Southern Florida Shelf also exhibits preservation potential for underlying Pleistocene substrate due to its physically hard character and reef development, resulting in a low energy wave environment. Therefore, sites may have survived in low energy environments such as the marshes of a delta or lagoon, or tidal flats fronting the ocean, since such sites often subside into the mud and become buried (Gagliano et al. 1982, 1984).

Native American land use is predicated on such factors as topography, access to water, soil drainage, and resource availability. Specifically, elevated and well-drained landforms were often preferred for habitation sites. Availability of raw materials, such as stone for the manufacture of tools, has influenced Native American settlement, as has the proximity and direct access to water. Within Florida, there are numerous types of water sources, including streams, rivers, wetlands, ponds, lakes, springs, and oceans, and these sources proved important as a drinking source for humans and the terrestrial animals they hunted, as a source of various edible aquatic species, as well as for water travel and bathing. Today, Florida's coasts support the state's most densely populated areas, and Native Americans also aggregated along the shore. Because the inundated portion of the shelf is an extension of the Coastal Plain, it is asserted that settlement patterning along the present terrestrial coastline should be mirrored in submerged settings of the Coastal Plain. Native American settlements are also readily found along the state's river and stream banks and at the springs. In fact, many spring sites in the interior of the state contain inundated Pleistocene-age cultural deposits with exceptional preservation, most notably at the Page Ladson site in the Aucilla River (Dunbar 2006a).

Unlike the northeast Gulf of Mexico, there are no major paleochannels extending onto the Florida continental shelf in the Atlantic; however, three offshore springs have been mapped on the eastern part of the state. The three Atlantic Coast submarine springs include the Crescent Beach Spring, which is a short distance off the coast of southern St. Johns County, Red Snapper Sink, which is about 30 km off the coast, east of the boundaries of St. Johns and Flagler counties (Rosenau et al. 1977), and Flagler Beach sinkhole (DeLoach 2000:223). All three areas represent high probability locations for encountering submerged cultural resources (see Figure 8.4).

Examination of elevation depths along the offshore portion of Florida's Coastal Plain permits an estimation of the amount of available land (now submerged) during differing periods in Florida's past. The submerged cultural resource sensitivity zones outlined below take into account the habitable regions of the continental shelf during periods when Florida was known to have been inhabited.

The modern east coast of Florida is generally composed of Holocene quartz sand barrier islands. Prior to 7000 B.P., the rate of sea level rise was too great for the prolonged stabilization of barrier islands and would have been unlikely to have sustained prehistoric populations before then. The stabilization of barrier islands is important because the lower topographic areas behind these islands never infill with marsh, but instead develop into open-water lagoons. Marshes in this environment are restricted to low-energy, narrow fringes along the lagoon/estuarine shoreline where they are protected from wave erosion (SAI 1981). This environment produces a highly productive backbarrier and lagoonal flats with substrates beneficial to mollusks, sea grasses, mangroves, fish, and numerous other species. More importantly, this area would have provided an attractive location for habitation.

The low energy level combined with the sediment trapping and sediment stabilizing effects of salt grass and mangroves would allow for the subsequent preservation of prehistoric sites and their protective estuarine muds. These sites and estuarine muds could lie buried beneath the active Holocene sands on the shelf during continued sea level rise and landward barrier island movement; recovery of peat during coring on the continental shelf could indicate potential preservation (Brech 2004). Also, the immediate nearshore environment contains abundant post 2000 B.P. archaeological sites.

Geological considerations are important to the understanding of site preservation and/or destruction. Factors such as wave and current action are paramount to the preservation of submerged resources. Moreover, recognition of such off-shore geological features as springs and sinks can aid in the detection of submerged sites.

Underwater archaeological investigations along Florida's Gulf Coast have successfully yielded early submerged cultural deposits (Faught 2004; Marks 2006). To the contrary, only one offshore submerged archaeological site has been identified on Florida's Atlantic Coast. This site has an intact Early Archaic component and Pleistocene-era megafauna, and is referred to as the Douglas Beach Site (8SL17); it was found 200 m off the coast in shallow waters (2–6 m in depth) approximately 5.6 km south of Fort Pierce Inlet (Murphy 1990). The site was associated with a peat deposit underlain by gray-green clay, and the occurrence of this underlying clay deposit might signify the type of sediments where other submerged sites exist.

8.4. ARCHAEOLOGICAL SENSITIVITY AND PRESERVATION POTENTIAL

Based on the most current sea level curves for this region, archaeological sensitivity is defined as follows and depicted in Figure 8.3.

- No Sensitivity. Areas 120 m and greater in depth are considered to be areas with No Sensitivity for prehistoric sites, since these areas were not subaerial during the LGM.
- Low Sensitivity. Areas that were subaerial beginning with the LGM until approximately 13,000 B.P. fall within the 120–60 m isobaths. Such areas may, but are unlikely, to have ever experienced human occupation while subaerial.
- High Sensitivity. High Sensitivity areas include all areas within the OCS that are shallower than 60 m. However, within the High Sensitivity area, some refinements are necessary for the Florida region.

Although the High Sensitivity area extends to the beginning of the Paleoindian period, there is little potential for intact Paleoindian sites in the OCS. There is very little archaeological evidence of occupation along the Atlantic Coast during this period based on terrestrial data. During this period, most Native American settlements in Florida were tethered to karstic areas where springs and sinks were present and where raw material for use in stone tool production was prevalent. Although two sinks are known to be submerged in the Atlantic Ocean off the coast of southern St. Johns and northern Flagler counties, these two water holes lacked the silicified Tertiary-age limestone that would have been sought as a raw material for tool production. Thus the lack of locally available cryptocrystalline lithic raw material might have deterred prolonged Atlantic Coast habitation during this early period in Florida prehistory; although the presence of minimally used transitory camps during this time remains a distinct possibility. Further substantiating the reduced potential for offshore Paleoindian period sites along Florida's east coast is the minimal number of Paleoindian projectile points reported for the 12 Florida counties that front the Atlantic Ocean. Specifically, only nine Paleoindian points have been reported from these 12 counties (PIDBA 2009), and this sparse number of points suggests that Paleoindian land migrations passing through these present coastal counties were minimal.

Even after the start of the Archaic period ca. 10,000 B.P., Florida's Atlantic Coast is assumed to have been minimally populated for some two thousand years; it was only shortly after this period that the first substantial occupation of Florida's east coast is documented. The earliest documented site in Florida, a mortuary pond in Brevard County known as the Windover Pond Site, dates to about 7400 B.P. Excavations from this unique site portray a sedentary society that apparently had a restricted mobility range and ceremonious mortuary practices. Although this site post-dates 8000 B.P., other such charnel ponds from earlier periods might exist beneath the ocean's waters. Depths for the time range of 8000–10,000 B.P. are -10 to -40 m below present.

The greatest potential for archaeological sites within the High Sensitivity area extends from the outer edge of the shoreline as it was exposed at 8000 B.P. to the present shoreline, and encompasses the Early to Middle Archaic periods (Figure 8.4). This zone is found at depths of 10 m and less. The present archaeological record shows a higher incidence of deposits of this

time period along the coastal strand than earlier sites dating to the Paleoindian period. This area does not extend very far from the present shoreline and exhibits a high probability for yielding deposits from seasonal camps dating to the earlier part of the Archaic period. The two known Atlantic Coast submerged spring sites (Crescent Beach Spring and Red Snapper Sink) are included within this High Sensitivity area.

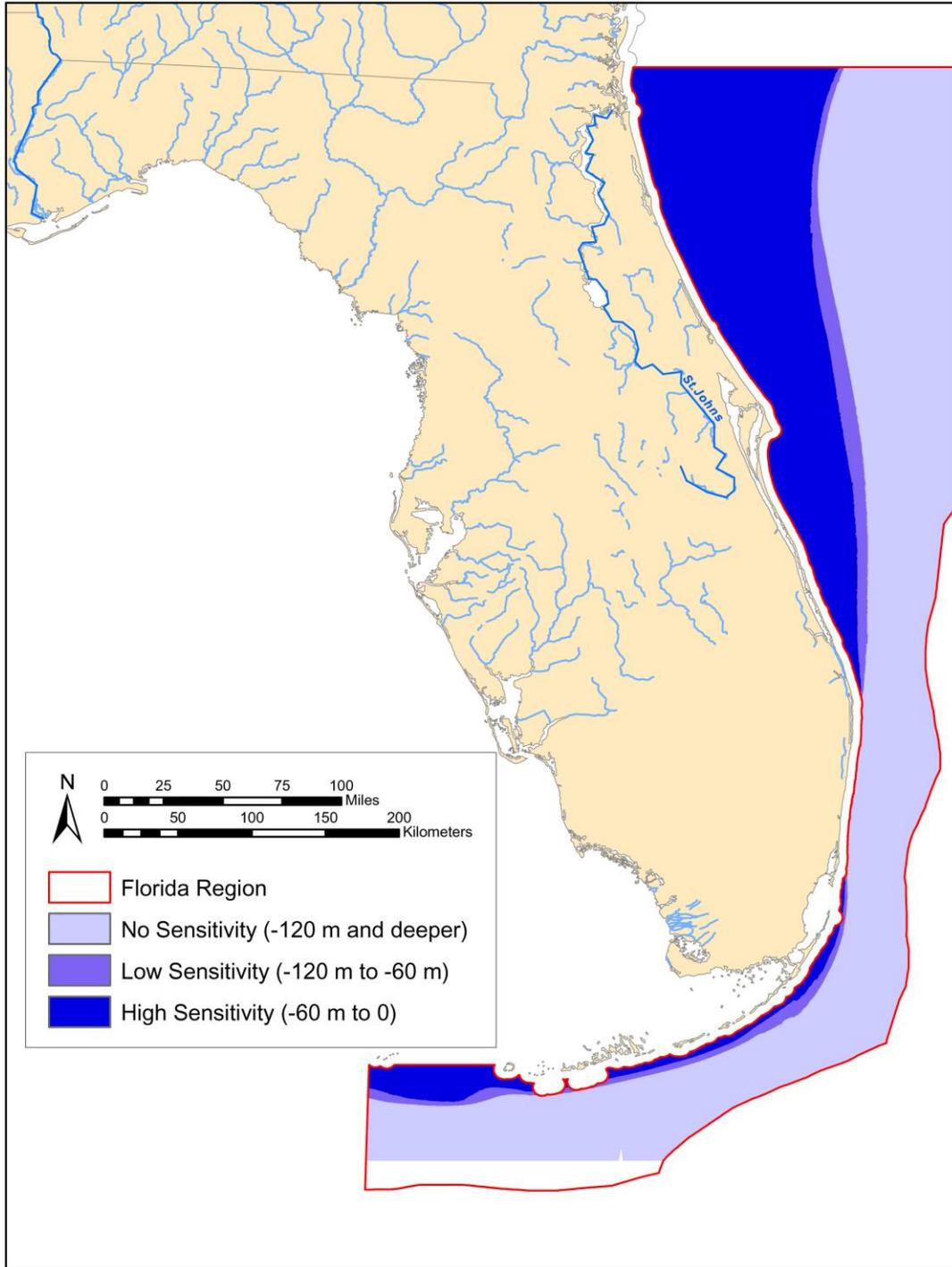


Figure 8.3. Archaeological Sensitivity map for the Florida study region.

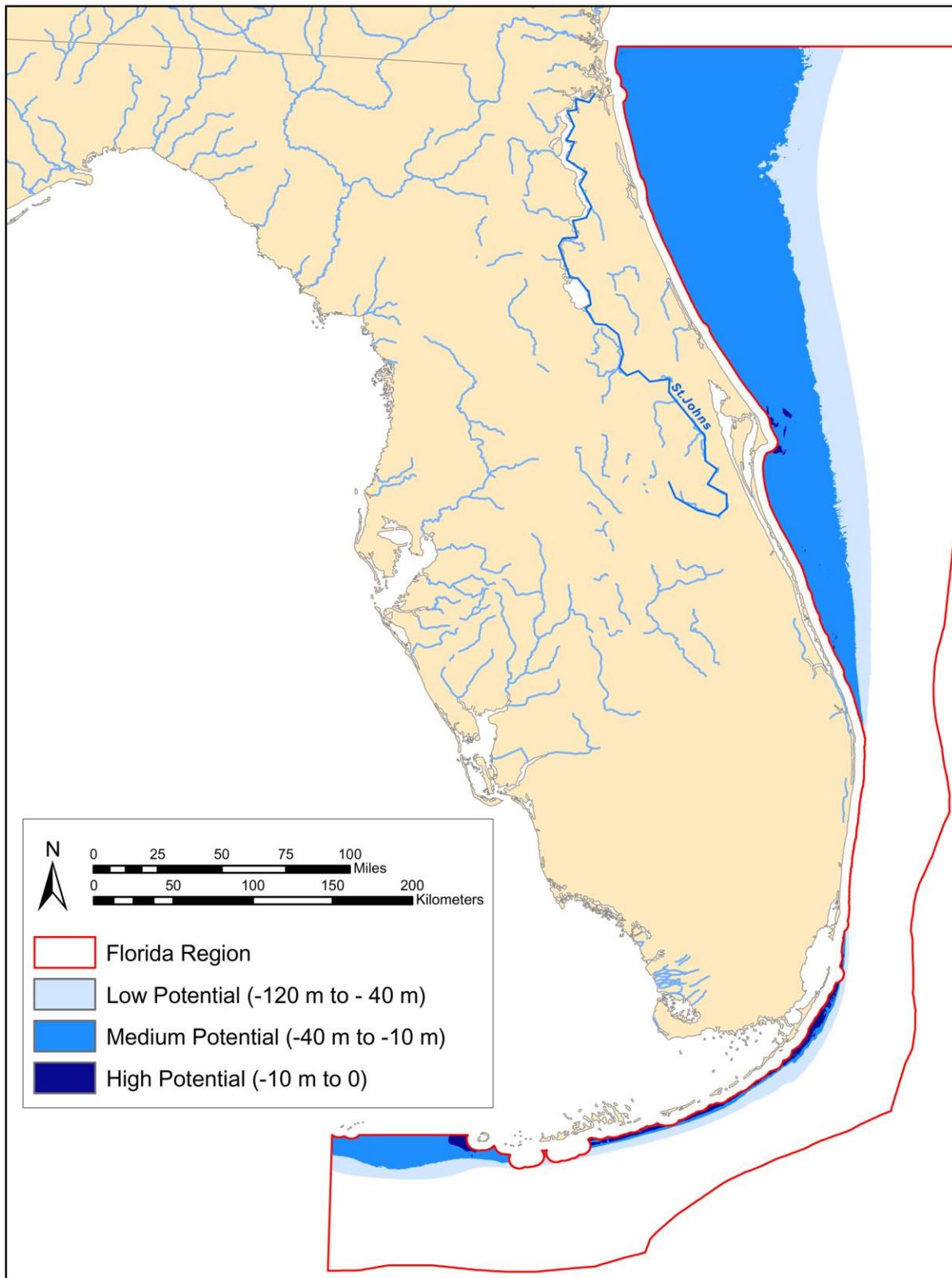


Figure 8.4. Site potential areas for archaeological sites within the High Sensitivity area in the Florida study region.

SECTION 3 – DISCUSSION

9. DISCUSSION–SYNTHESIS OF MODEL

Any approach for identifying where prehistoric sites may exist on the Atlantic OCS must address a few of basic questions. First, when were people here? Second, what portions of the Atlantic OCS were subaerial at a time when human occupation was present? And, third, where would such sites, assuming they once existed, have survived marine transgression and be preserved? Finally, assuming they have been preserved, what techniques should one employ to find them?

This chapter summarizes the research presented in Chapters 3–8 and presents considerations and an approach for locating prehistoric sites on the OCS. Modeling site potential and preservation potential depends on a reconstruction of sea levels and geomorphology. Regionally distinct geological and environmental processes have been at work since the Late Pleistocene, and thus the discussion in Chapters 3–8 will be more pertinent to planning for any particular project. The current chapter outlines the general principles on which the regional models are based, and notes certain weaknesses and gaps in current scholarly work on issues related to sea level and geomorphology that can be refined through further research, and that should be taken into account when planning investigations for a particular undertaking.

9.1. TIMING OF HUMAN SETTLEMENT

Chapter 2 discussed the current knowledge of the prehistoric occupation of the East Coast. The best data currently indicates that Paleoindians were the first to occupy the Eastern Seaboard, but there still remain hints of possible pre-Paleoindian settlement. From the best evidence available, the earliest Paleoindian component, Clovis, dates no earlier than 13,000 B.P., although the precise dating of this Clovis period remains largely uncertain due to the paucity of sites. Assuming that a pre-Clovis occupation is possible, this date might be pushed back another 500–1,000 years, depending on which possibilities one might be willing to entertain for an earlier entrada into North America. The support for a European-based settlement of the Atlantic Seaboard is exceedingly limited, and remains little more than informed speculation. If one assumes an early, coastal migration model originating from Beringia that can account for an occupation at Monte Verde, Chile, at ca. 13,800 B.P., a date of 13,000 B.P. also seems reasonable for a likely early date of human occupation in the study area. Therefore, while not to discount the possibility of an earlier occupation of the East Coast, there are no data to indicate that significant resources should be invested searching for submerged prehistoric sites that may date earlier than 13,000 B.P. It is this cutoff in time that defines the High Sensitivity areas for the model.

The timing of human settlement in the region is important because it helps to set some parameters on the depths at which prehistoric sites are possible. Effective exploration of OCS for surviving prehistoric sites will, however, closely depend on correlating when sites may have been formed while portions of the OCS was subaerial with contemporary ocean depths.

9.2. USE OF SEA LEVEL CURVES

Defining what portions of the Atlantic OCS would have been subaerial 13,000 years ago is not a straightforward undertaking. Sea levels during the Late Pleistocene and early Holocene

were influenced by a wide range of factors, and involved not only the surface level of the sea but the surface level of the land mass as well (Dix et al. 2008:13). A number of scholars have prepared sea level curves, using a combination of sea level indicators such as shells, tree stumps, bulk saltmarsh-peat, plant remains, foraminifera, and many other formerly-living plants and animals. These materials are dated by various methods and plotted based on their elevation to create sea-level curves for various regions. However, there is a great deal of regional variability in sea levels, with the impacts of post-glacial continental rebound (due to relief from the weight of glaciers on the land surface) and hydro isostatic rebound (uplift in coastal areas resulting from the increased weight of water associated with rising sea levels) experienced differentially.

Despite the many efforts at refining regional sea level curves, to a certain extent this work is as much art as science. As Pirazzoli (1991:21) notes, “most sea-level curves are not deduced mathematically from the data, but interpreted by their author in order to follow more or less closely certain index points considered more reliable and to express trend variations deduced from other information and from interpretation of observations which are not always strictly quantifiable. From this point of view, as in many scientific fields depending mainly on observation, a linear sea-level curve is constructed not only from data, but also from subjective ideas, and in some cases preconceived theories of their author.” The difficulty in understanding relative sea level changes during earlier periods of the Holocene, for example, is compounded by the lack of data points, so researchers extrapolate curves, often without detailing the methods or assumptions underpinning them.

This study has endeavored to summarize the most recent literature on sea level rise, and illustrates both the regional differences and gaps in knowledge (Table 9.1). In the Gulf of Maine, for example, isostatic depression of the land by the weight of the ice impacted sea levels in ways not experienced to the south. Likewise, as the glaciers melted and worldwide ocean levels increased, isostatic rebound in that region slowed the pace of RSL rise between 11,500 B.P. and 7500 B.P. Assuming the existence of a rapid period of eustatic sea level rise during MWP 1b (ca. 11,500–11,100 B.P.), RSL changes in the Gulf of Maine differed dramatically from regions further south.

Table 9.1. Sea Level Curves for Atlantic OCS.

Region	References	Sea Level (Meters) & Years B.P.				
		20,000 LGM	13,000–12,500 Paleoindian	10,000	8000	6000
Maine	Kelley et al. 2010	60	60	20	19	N/A
S. New England	Oldale 1992	107	70	40	20	10
New York-New Jersey	Wright et al. 2009	120	70	30	19 (7.5k)	12 (5k)
Middle Atlantic	Wright et al. 2009; Nikitina et al. 2000; Horton et al. 2009; Mallinson et al. 2005	120	70	32	15	12
Georgia Bight	No local research; inferred from global eustatic curves and constrained by research in NC and FL	110	70	58	25	10
Florida	Balsillie and Donoghue 2004	120	60	40	25	10

The sea level curve for the Southern New England region relies on the research undertaken by Oldale (1992). Based on his calculations, sea level during the LGM was 107 m below its present level. During the beginning of the Paleoindian period in the region, sea levels were approximately 70 m below present sea level, and were at 40 m below present by ca. 10,000 B.P., the start of the Archaic period. By 6000 B.P., sea levels were about 10 m below present. In the New York–New Jersey region, the most recent research by Wright et al. (2009) indicate that the LGM sea levels were approximately 120 m below today's, a trend that is similar down the coast to Florida (although researchers in the Georgia Bight have assumed a depth of -110 m in that region at the LGM). Seventy meters below present currently is a generally accepted depth for the the start of the Paleoindian period (ca. 13,000 B.P.) south of the Gulf of Maine, with more variability region to region as one moves closer to the present. These differences may be caused by a number of factors, ranging from actual local variations in RSL from isostasy to dating errors. As noted above, some of the differences also may reflect the fact that the curves are drawn to connect sometimes sparse data points further out in time.

Reconciling the many variables and inconsistencies among sea level curves is beyond the scope of this project. For future undertakings within the Atlantic OCS, applicants should ensure that the most current research on sea level rise is used to determine which portions, if any, of their project area would have been subaerial as far back as 13,000 B.P.

Once the appropriate sea level curve has been selected, the paleoshoreline from ca. 13,000 B.P. should be reconstructed by using gridded bathymetric data. A starting point should be the bathymetry available from NOAA's National Geophysical Data Center, U.S. Coastal Relief Model (NOAA 2010). These data, which incorporate 3 arc-second data from sources such as the U.S. National Ocean Service Hydrographic Database, the U.S. Geological Survey, the Monterey Bay Aquarium Research Institute, and the U.S. Army Corps of Engineers, can be imported into a Geographic Information System such as ESRI's ArcGIS and modified into classified fields, allowing selection of appropriate depths. This process provides only a gross overview of a paleoshoreline location at a given point of time. Accordingly, it is recommended that the data be refined locally within a project area by means of bathymetric survey, which will provide more accuracy and enable a better understanding of the seafloor topography within the project area.

Bathymetry also is a good starting place, but it is important to recognize that conceptually draining the ocean to the current bathymetric depths does not provide an accurate view of what the project area would have looked like when subaerially exposed. The impacts of marine transgression need to be considered, since areas of the seafloor that now appear to be flat may represent former valleys or paleochannels or paleosols now covered in sediment. Likewise, the configuration of valleys on the seafloor reflects channel erosion during transgression and directional reworking due to bottom currents, tidal actions, and storm patterns. Methods for reconstructing the geomorphology of the subaerial topography include subbottom profilers paired with coring, and are discussed in more detail in Chapter 10 below.

9.3. SITE LOCATION AND SURVIVAL

There are myriad factors that can influence—or in some cases dictate—the potential for an archaeological site to survive transgression intact, including disturbances while the site was

subaerial, forces associated with transgression, and post-inundation impacts. At a fundamental level, however, there is a key prerequisite for preservation of an inundated site: it must be buried in terrestrial or low-energy marine sediments prior to the transgression of the ocean's rising waters (Waters 1992). In the absence of such pre-inundation burial, the re-leveling process of marine transgression will simply destroy the site. Pre-inundation burial is no guarantee of site preservation, but simply a necessary condition.

Settings that have the most potential for site burial, then, should include well developed marsh-lagoon-barrier systems and flood plain-marsh-estuary systems—areas that would have been attractive to human occupation, but also conducive to low-energy sedimentation either prior to or during the early stages of transgression (Moir 1979:1-206). Stright (1990:457) identified “landforms such as river valleys, bays, estuaries, lagoons, lakes, ponds, sinkholes and subsiding deltas” as low-energy environments where sites could be buried deep enough to survive the impacts of marine transgression. Conversely, contexts where sites are exposed to the direct impact of breaking waves, as well as the subsequent oscillatory water motion along the seabed when inundated a few meters, would eliminate any potential for site survival (Bailey and Flemming 2008:2159). Where favorable environments do not exist, the impact of waves and currents—particularly during storm events—could be highly destructive, leaving little more than resorted artifacts. Therefore, beaches, dunes, washover flats, and major headlands are areas where preservation is unlikely to exist (Swift 1976). Exceptions exist where paleo deltas are present with deeply buried artifacts, or where spits have developed, or other local conditions allowed stepwise retreat of the coastline as sea level rose, such that sites on the lee side of dunes or on sheltered beaches are protected from direct shoreface erosion and instead are rapidly submerged.

The rate of sea level rise also is a major factor in both site formation and site preservation throughout the study area. During periods of slow sea level rise, stable productive estuarine settings were created that were attractive for human settlement. Lower energy environments tend to yield the highest returns in terms of biological productivity, since slow currents allow the accumulation of a sediment base for aquatic plants, which will in turn support invertebrate life and protective areas for fish hatcheries. In addition, higher net productivity tends to coincide with broad, shallow bathymetry, particularly at fresh and saline water interchanges (Perlman 1980). Lagoons and estuaries are among the most productive coastal features, and thus are likely to have attracted prehistoric hunter-gatherers. Thus, slow sea level rise likely facilitated archaeological site formation. However, as a general rule, slow rates of sea level rise also have a greater probability of negatively impacting the integrity of coastal archaeological sites, as tidal scouring of adjacent upland or drowned upland archaeological sites would be greater during periods of relatively stable sea levels than it would be during periods experiencing rapid marine transgression.

There are, of course, exceptions to the general rule. In certain areas and settings, relatively slow rates of sea level rise can result in the preservation of drowned archaeological sites with intact features. As such, there are conditions where the integrity of drowned prehistoric archaeological features and deposits would not be negatively impacted by stable sea levels. The upper reaches of slow-moving tidal creeks, for example, could provide such a setting. The regular input of organic detritus and a lack of open water, which would limit the degree of fetch-related erosion, could provide a situation where anaerobic and anoxic conditions could be

attained over a very short period of time. If so, the anaerobic and anoxic conditions would limit the degree of bioturbation disturbance to the archaeological features and deposits. In these settings, the drowned archaeological remains would be preserved.

Rates of marine transgression have varied in the Atlantic OCS over the past 13,000 years, which defines the period of High Sensitivity for the presence of archaeological sites. It is assumed that the sea level rise rates during this period would have greatly impacted the long-term preservation of archaeological deposits that had only been submerged recently. Fetch-related wave erosion, littoral drift, tidal scouring, and bioturbation represent some of the natural processes that would have impacted archaeological sites during the transition from an upland site to the offshore swash and berm zone. However, it is assumed that during periods in the past that experienced rapid rates of marine transgression, the integrity of archaeological landscapes, deposits, and features would have had a greater chance of long-term preservation.

Rapid rates of sea level rise would not have eliminated the natural processes impacting archaeological deposits. Rapid marine transgression would, however, have limited an archaeological site's duration of exposure to these natural destructive forces. When a former upland archaeological site is situated offshore in water depths below wave base, it is assumed that the archaeological remains would be preserved *in situ* or near the location of original deposition.

The rapid burial of an archaeological site also has the benefit of possibly limiting some aspects of post burial processes that would cause disturbance to the site's integrity. The quicker a drowned archaeological site reaches a setting with anaerobic or anoxic conditions, for example, the more likely the integrity of the site will be preserved. As Lowery (2009) notes for sites in and around the coastal areas of the Delmarva Peninsula in the Middle Atlantic region, tidal marshes are teeming with numerous burrowing crab species. If sea level in a region is stable or rising at very slow rates, bioturbation via tidal marsh and inter-tidal organisms would negatively impact the integrity of coastal or drowned upland archaeological sites. Along the lower Chesapeake Bay and the Atlantic coastline, tidal marshes with drowned upland archaeological sites can, during the summer months, contain literally millions of burrowing fiddler crabs. Burrows extend a foot or more below the surface and vary in diameter depending on the size of the individual crab. As a result, old sediments and archaeological remains can be brought to the surface and modern surface organics and non-archaeological sediments can be introduced into the deeper strata. Rapid submergence is no guarantee of protection from such bioturbation, as Ferrari and Adams (1990) have noted in their discussion of the impact that burrowing by various fish and crustaceans can have on marine sediments. It may, however, limit some of the intensive disturbances documented in tidal and inter-tidal settings.

As noted in Chapters 3–8, archaeological site preservation potential on the OCS is tied to unique, protected settings in different regions. Site preservation may also be related to regional topography, resistance of sediments to erosion, sediment supply, depth of erosion and wave energy, and tidal range (Belknap and Kraft 1981; Waters 1992). Site protection may be provided by bedrock formations. Morphology of the Coastal Plain prior to transgression is important, since sites that are lower in topography (such as sites in river valleys or adjacent to low-lying lagoons) will withstand erosion comparatively well, as they are below the height of most of the impact energy resulting from waves, tides, and currents. The cohesive strength of sediments will

determine their relative ability to resist erosion, while sediment deposition can compensate for any instability in the original matrix. Recently, Leach et al. (2009) reported on a preserved submerged landform dating to 6300 B.P. in approximately 13 m of water off the coast of Maine, although not within the OCS. They postulate that preservation at this locale was likely due to armoring of the sediment package by bedrock and a relict oyster bed, as well as rapid sea level rise.

In the Gulf of Maine, sheltered areas that developed during a slowstand may have been protected from marine transgression because of spit formation. Whereas one would normally assume that coastal processes would cause considerable erosion during periods of slow sea level rise, these forces also created conditions that may have preserved certain contexts that would have been attractive for human occupation. Thus, some of these sites may have been preserved because spits offered some protection from marine transgression. In the New England and New York–New Jersey regions, there is evidence for intact, relict surface features or paleosols that may contain preserved sites. The presence of such features (e.g., Rampino and Sanders 1980; Robinson et al. 2004; Sanders and Kumar 1975a, 1975b) suggest that stepwise retreat may have aided burial of archaeological sites as well in these regions, although no actual intact sites have yet been reported.

Seismic evidence in the New York Bight has indicated the potential for preserved lagoonal settings that may have been attractive settings for prehistoric occupation and offer the hope of site preservation. Nordfjord et al. (2009) identified two examples in their seismic profiling of the seafloor with apparent preserved remnants of back-barrier morphology exist at depths of 50–60 m, which would be associated with the Paleoindian period. Likewise, Sanders and Kumar (1975a) have identified similar seismic evidence they interpret as a preserved back-barrier, which was noted at a depth of 24 m off the coast of Fire Island, New York. Nordfjord et al. (2009) offer two explanations for how such features might have survived erosion during shoreface retreat. One possibility they suggest is that these features represent pauses in the retreat of the shoreline during the last transgression not yet documented in regional sea level curves, which may have provided “time for barrier systems and related deposits to develop that were substantial enough not to be erased by the subsequent passage of the shoreface” (Nordfjord et al. 2009:239). Another possible explanation is that there may have been more topography seaward of these features that protected them initially from transgression, but when this topography was eventually flattened, the localized shoreface retreat would have been rapid, enhancing preservation (Nordfjord et al. 2009:239).

In the Middle Atlantic region, research identified the presence of likely paleo shelf-edge deltas off the coast of North Carolina, which would have been preserved during a period of relatively rapid sea level rise. Such relict features suggest the potential for preserved archaeological sites as well. Further south, in the Georgia Bight, geological conditions indicate that site preservation is most likely along paleochannels, where archaeological sites may have been buried prior to inundation. Because of intensive scouring of the seafloor in the region, any archaeological sites preserved would likely be deeply covered in sediment—making discovery challenging. On the Florida coast, there is an absence of any major paleochannels extending into the OCS. Therefore, the most likely settings for intact prehistoric sites are more limited, and settings such as offshore springs represent the most likely location for both prehistoric occupation and survival from transgression.

While sites dating to the early prehistoric period may have existed on the OCS prior to inundation, they did not necessarily survive marine transgression. Many variables are at play with respect to site preservation or destruction, including the type of landform, the site's position vis-à-vis a shoreline (i.e., would the site have been in a backshore area that would have experienced sedimentation rather than direct, erosional wave impacts), and the rate of marine transgression (with slower rates likely impacting areas more thoroughly). However, even with faster rates of marine transgression, shoreface locations would have experienced significant impacts through many years or decades of natural forces, so it is unclear if the rate of marine transgression would have allowed sites in such locations to survive. Accordingly, it is important to evaluate locations where sites may have survived on a case-by-case basis, focusing on the unique characteristics of the local geography and stratigraphy. Current mapping of relict landforms across the OCS is inadequate for the purpose of identifying potential locations of preserved sites. Detailed studies of geomorphology using seismic sub-bottom profiling and coring in conjunction with bathymetry are needed to characterize settings that could hold intact sites.

9.4. SUMMARY

The process for exploring the potential for submerged prehistoric sites, then, can be summarized as follows. The first step in launching such an investigation is to obtain information on the regional and local cultural context and environmental setting. This is accomplished by consulting with the SHPO, local Tribes, and other interested parties, conducting a comprehensive literature search to document the archaeological record on the nearest land adjacent to the offshore study area, and reviewing the available geological literature to obtain an understanding of the area's geomorphological history and the current environmental conditions. The second step is to get a sense of the "shape of the land" underwater by examining bathymetric charts, or, if available, existing multibeam bathymetric and subbottom records to look for evidence of potential vestigial elements of the pre-inundated landscape within the study area. The third step is to apply local relative sea level rise models to the study area's bathymetry to attain a general sense of where shorelines may have been located and when various parts of the inundated landscape could have been subaerially exposed. The fourth step is to develop and execute a combined program of geophysical survey and geotechnical sampling to identify archaeologically sensitive landforms and paleosols, which once located, may then be subjected to different forms of sub-surface archaeological testing to locate archaeological deposits.

As the authors of the Research Planning, Inc. et al. report note (2004:60), the hypothesis that key relict landforms like stream channels and estuary complexes served as attractors for prehistoric utilization, and thus have high archaeological sensitivity, remains largely untested along the Atlantic coast. Intensive subsurface testing in advance of construction and/or monitoring by an archaeologist during offshore work (particularly dredging operations) would serve to test the site patterning model. In the case of monitoring, if artifacts were encountered during construction, work would stop or move to another location until the find could be mapped and verified (i.e., following the protocol discussed in Research Planning, Inc. et al. [2004:59–60]).

Until findings accumulate to disprove a model for prehistoric settlement along coastal streams and estuaries, survey efforts should focus on these portions of the submerged landscape.

The methods discussed in the next chapter provide cost-effective and reliable tools for characterizing the landforms and prehistoric site potential within a given project area.

Archaeological exploration for submerged prehistoric sites on the Atlantic OCS takes on some urgency in light of the accelerating rate of potential site destruction resulting from offshore dredging, drilling, and construction activities. Given the significant archaeological questions that can only be answered through investigation of early sites along the relict coast, it is important to protect and study these unique components of the North American archaeological record.

There are a number of methods available to search for the appropriate contexts for submerged sites. The objective of these methods is first to identify areas with reasonable potential for containing prehistoric sites and, second, to sample targeted areas with high potential to determine if preserved sites exist. The current state-of-the-art methods for identification and investigation of submerged prehistoric sites are discussed in Chapter 10. How such methods can be applied in the context of federally permitted undertakings is covered as well.

10. RECOMMENDED FIELD SURVEY METHODS

10.1. INTRODUCTION

Early prehistoric archaeological resources are virtually invisible to remote sensing equipment available today. However, the association of Paleoindian and Archaic sites with relic landforms appears to be the key to locating and identifying areas of high potential. There have been few systematic surveys conducted specifically to locate submerged prehistoric sites in the Atlantic to date. A notable exception is Robinson et al.'s recent study in Nantucket Sound for an offshore wind power project (Robinson et al. 2004). Studies carried out elsewhere have illustrated the value of correlating potential site locations with submerged landscape features. The Sabine River study carried out by Pearson et al. (1986) over two decades ago and current research carried out by Faught (2003, 2004) off the Gulf coast of northern Florida provide the most convincing evidence of the value of that correlation. Likewise, a team from Parks Canada has explored the continental shelf in the Hecate Strait off British Columbia, where ancient human occupation sites may rest in as much as 150 m of water. The Canadian team has employed high-resolution multibeam sonar, remotely operated vehicles (ROVs), and manned submersibles to image the sea floor, and coring and grab methods to sample it (Carper 2007). In conducting surveys designed to identify relic landforms and prehistoric archaeological sites, acoustic instruments appear to be the most effective (Faught 2003; Hoyt et al. 1990; Research Planning et al. 2004).

The three instruments that generate the most useful data are multibeam echo sounders, side scan sonar, and subbottom profilers. The side scan sonar and multibeam echo sounders generate high-resolution data that can be used to reconstruct and map surface geological features that reflect paleotopography. Used in conjunction with highly sophisticated terrain modeling programs, acoustic data from those instruments can be turned into highly detailed bottom surface maps that cover broad areas. Characteristics of the bottom surface can be associated with buried geomorphological features using high-resolution subbottom profilers. With sufficient data, sophisticated computer modeling programs can be used to develop three-dimensional, georeferenced models of relic landforms that could be associated with areas that have prehistoric archaeological site potential. Using GIS software to store, analyze, and project the data, archaeologists and submerged cultural resource managers can identify high priority areas for research or protection. Areas of high potential where sea floor disturbances are proposed can then be surveyed using higher resolution geophysical techniques (like seismic reflection profiling studies), coring, and direct observation of the sea floor using remotely operated vehicles (ROV) or direct submersible investigation. Intensive studies of submerged cultural resources will be expensive, and developers may choose to avoid areas of high potential, rather than carry out costly investigations.

Each of the methods available to characterize the sea floor and identify areas of high potential for cultural resources are described below, along with methods for sampling and investigating such areas. There is also a brief discussion of planning considerations related to the cost and logistics of conducting such studies.

10.2. UNDERWATER SURVEY METHODS

10.2.1. Multibeam Bathymetry and Backscatter Intensity Data

One remote sensing method relevant to detecting areas of high sensitivity for prehistoric sites is high-resolution multibeam swath bathymetry (where the data set consists of both depth and backscatter/reflectivity information) to image surficial features on the sea floor. This method allows the identification of relict landscape features such as stream channels along which prehistoric sites would have been concentrated. Multibeam bathymetry and backscatter intensity data provide information on water depth, sea floor morphology, and sediment types. Multibeam systems are so-named because they consist of a group of sonar beams directed at and reflected back from the ocean floor, as opposed to earlier, single beam systems. Bathymetric data and sea floor composition are interpreted from the speed and intensity of the reflection of the acoustic signals, which are collected simultaneously and then processed. Multibeam systems collect data in a swath that typically extends beyond either side of the host vessel along the ship's track to a distance of five to seven times the depth. Ship tracks are designed to overlap and provide 150 percent coverage of the study area. These tracks are then combined to form a seamless image of the morphology of the ocean floor, as well as detailed bathymetric data. Because wider swaths are gathered in deeper water, surveys are much faster in greater depths.

Multibeam bathymetry and backscatter intensity data is the first information that should be collected during a survey for submerged cultural resources. The bathymetric data provides a detailed image of sea floor morphology, allowing identification of landforms and an accurate assessment of depths within the study area. Backscatter data can provide generalized information on sea floor bottom types, based on the intensity of acoustic returns. When combined, these two data sets establish the basis for more detailed studies of the sea floor and underlying stratigraphy.

10.2.2. Side Scan Sonar

Side scan sonar is also an acoustic technique, but is focused on a detailed image of sea bed characteristics rather than bathymetry. This technique also can be used to identify shipwrecks, but in the context of prehistoric site survey, it can serve to characterize the sea floor with greater resolution than multibeam bathymetry. Side scan sonar is accomplished using a towfish that both sends and receives acoustic signals and reflections from the sea floor. As in multibeam surveys, side scan sonar surveys image swaths of the sea floor several times the water depth. Ship tracks are designed to overlap and provide 150 percent coverage of the study area, allowing production of maps showing sea floor characteristics. When combined with multibeam bathymetric data, a great deal of information on the morphology and composition of the sea floor is obtained. This information is critical to identifying geomorphological settings of high archaeological potential.

10.2.3. Seismic Reflection Profiling

Seismic profiling is a geophysical technique used to gather information about sea floor subsurface data. This technique also employs acoustic energy, but rather than receiving and processing returns strictly from the ocean floor, the signals are designed to penetrate subsurface sediments. Reflections from interfaces between layers of varying acoustic properties are recorded and used to create a seismic-stratigraphic profile of the material beneath the ocean floor. The

depth of penetration into seafloor sediments is determined by the frequency of the acoustic signal and the sediment characteristics. Higher frequency (CHIRP) systems provide greater resolution, but less depth penetration, and provide excellent results in settings with fine-grained sediments. Lower frequency (Boomer) systems produce greater penetration of thick sediment sequences, but generally with less resolution.

Seismic reflection data is produced as a series of 2-dimensional profiles along the research vessel's tracks, unlike the 100 percent coverage that can be achieved with multibeam bathymetric studies and side scan sonar investigation. Thus, the spacing of seismic reflection profiles is important if the study area's stratigraphy is to be adequately investigated. Seismic reflection profiles are frequently collected using gridded cruise tracks (lines oriented at right angles), with the spacing between lines determined by the approximate size of landforms or buried features to be imaged. Data from multibeam bathymetric studies, as well as any previous work in the study area can be used to guide this decision. More closely spaced data collection, with a maximum lane spacing of 15 m, may be used to further refine interpretations in areas identified as having a high potential for cultural resources. Prominent acoustic reflections that occur throughout a study area can be selected in some processing systems and a surface of that reflector can be interpolated and the thickness of overlying sediment mapped.

The complementary properties of these two seismic reflection techniques indicate that both should be used in a survey for submerged prehistoric cultural resources. The higher frequency data will provide higher resolution data of near bottom stratigraphy, while the lower frequency technique will investigate more of the subsurface stratigraphic package. While most culturally sensitive areas may be concentrated in the upper portion of the subsurface sediments, it is difficult to understand the geologic history and setting of the study area without seeing as much of the section as possible. In addition, this information is routinely collected for engineering studies for offshore projects. With advance planning, survey for culturally sensitive areas can be accomplished at the same time geotechnical and engineering information is collected, reducing costs.

10.2.4. Vibracoring

Vibracoring may be required for the analysis of high potential geomorphic settings, to allow further analysis of the seabed subsurface geology. While it is highly unlikely that artifacts will be recovered by vibracoring, the sediments and faunal and floral remains obtained provide information about the physical setting and age of the area. A geotechnical program of vibracoring also can determine the presence or absence of paleosols likely associated with prehistoric occupation. This information can then be used to further assess a study area's cultural resource potential. Vibracores previously taken in portions of the Atlantic sea floor suggest that the top 1 m (and sometimes deeper) of sediments are recent and/or reworked (LaPorta et al. 1999; Schuldenrein et al. 2000). However, it is possible that intact former land surfaces that may contain prehistoric archaeological deposits are buried beneath the sea floor. If proposed seafloor impacts will disturb more than the top meter of sediment, it is recommended that vibracoring (or similar method of coring) be undertaken in areas of moderate to high potential for the presence of prehistoric sites. The goal of vibracoring would be to determine if there are intact Late Pleistocene and Holocene strata in areas slated for impact. Analysis of the vibracore samples would consist of lithostratigraphic evaluation, dating of any organic material, and identification

of any pollen, macrofloral, and/or foraminiferal samples recovered. If intact strata are identified, then it is recommended that those areas be avoided. If avoidance is not possible, then more subsurface testing and/or monitoring to determine if prehistoric materials are present may be recommended.

10.2.5. Remotely Operated Vehicles (ROVs), Autonomous Underwater Vehicles (AUVs), Video Surveys and Submersibles

Ground-truthing of high sensitivity areas identified by remote sensing that lie within an area of proposed impact is typically done by vibracoring, although in cases where surficial deposits are suspected (e.g., around rock outcrops), then it may be accomplished by direct visualization by scuba divers or by ROVs, depending on the bottom conditions (e.g., depth, currents, visibility). These methods are also used to investigate areas once cultural resources have been identified at the seabed surface. ROVs act as the eyes, and sometimes hands, of the investigators. They are, however, limited to material exposed at the seafloor. The equipment is operated tethered from a vessel. A ROV will allow investigation of seabed conditions, visual analysis of features (like rock outcrops, shipwrecks, etc.), and inspection of exposed artifacts. Use of ROVs is restricted by water clarity. Fine-grained bottom sediments can create turbid conditions that greatly reduce visibility. AUVs are programmed to “fly” over the bottom and can be equipped with cameras and a variety of geophysical sensors. In locations like the Gulf of Maine, with a large lobstering industry, lobster buoys may preclude use of AUVs.

Video surveys with a towed camera can provide detailed color images of the seabed capable of imaging artifacts and seafloor sediment. These surveys acquire a series of overlapping images along a transect of the seabed. Since it is difficult to know the precise position of the camera for every frame, transects are often short.

Submersible vehicles provide a way for scientists to make direct observations at the seafloor, and in some situations, collect samples. As with ROVs, water clarity can create visibility issues for studies employing submersibles. Submersible vehicles are expensive to build, maintain, and operate, so costs associated with this type of investigation are high.

10.2.6. Geophysical Survey Planning

Initial survey to identify high potential areas for submerged cultural resources requires some of the same information and employs many of the same techniques as those used by the offshore development applicant. Thus, the multibeam bathymetry and backscatter intensity data, side scan sonar, and high resolution (CHIRP) and deep penetration (Boomer) seismic reflection profiling, as well as precision mapping carried out for other aspects of project planning can also serve the needs of cultural resource assessment, with data collected simultaneously that will serve a variety of needs. Depending on the size of the research vessel and project budget, seismic reflection, multibeam and side scan sonar profiles can usually be collected simultaneously. Generally, multibeam data can be gathered at a higher vessel speed than the other techniques, and if such a system is leased, it is sometimes more cost effective to collect bathymetric data first and use it to plan seismic and side scan sonar lines. Interferometric side scan sonar methods additionally provide good quality side scan images and bathymetric data, especially in shallow water. More

detailed, higher resolution surveys should be reserved for examination of identified submerged cultural resources, such as shipwrecks and areas of high prehistoric archaeological potential.

Even when investigations are carried out in cooperation with project engineers, the work should be performed under the supervision of a marine archaeologist, with marine archaeological staff on board the survey vessel for the duration of the survey to monitor data as it is acquired. This arrangement should allow the archaeologist to generate a preliminary “real-time” inventory of acoustic reflectors with moderate to high potential for representing archaeologically sensitive inundated paleosols. Upon completion of the field investigation and post-processing and plotting of the survey data, acoustic reflectors identified by the field archaeologist as having moderate to high potential for representing archaeologically sensitive areas should be reevaluated by the archaeologist using the post-processed data in combination with core logs and photographs from any geotechnical coring/boring performed as part of the project. The results of these combined analyses should then be used to generate a final list of archaeologically sensitive areas recommended for avoidance or further investigation and National Register evaluation.

Specific guidelines for remote sensing surveys updating current BOEM protocols are provided in Research Planning, Inc. et al. (2004:35–39, 53). They recommend the use of sub-meter differential global positioning systems for navigational accuracy, acoustic positioning systems that track towed sensor position, a track line spacing no greater than 30 m, and lines for anomaly definition spaced 10 m on either side of initial contact.

Following these updated guidelines is likely to result in the discovery of more archaeological sites (both prehistoric and historic period) than would have been identified under the old standards, thus possibly preventing future incidents of accidental site disturbance during construction.

10.3. SUMMARY

Investigation of the Douglass Beach Site (8FL17) in Florida state waters illustrates the types of analyses possible in the context of underwater prehistoric sites, analyses that are commonly employed at terrestrial sites (Murphy 1990). In addition to radiocarbon dating of organic materials recovered, sedimentary and geochemical analyses can be employed to understand taphonomy and identify the signatures of human occupation in sea floor sediments (to help refine expectations about evidence of archaeological deposits elsewhere), palynological analysis can be conducted to assist in environmental reconstruction, ethnobotanical and faunal analyses can be carried out on materials whose preservation state may be enhanced by submersion, and artifacts and their provenience can be analyzed as is done for terrestrial sites, although stratigraphic recovery is limited to approximate strata through propeller wash deflector modifications, and small samples obtained through coring. The information potential of submerged sites is comparable to those on land, and could be key to our understanding of the peopling of North America and coastal adaptations in the early millennia of human occupation. The Douglass Beach Site was preserved in a back barrier setting, where it was buried by overwash sediments during transgression, protecting it from high-energy shoreface erosion (Murphy 1990:52). Sites in comparable settings likely exist throughout the Atlantic OCS, and await discovery through the survey methods discussed here.

SECTION 4 – HISTORIC SHIPPING AND SHIPWRECKS

11. ATLANTIC OCS SHIPWRECK DATABASE

11.1. INTRODUCTION

One of the goals of this project was to compile a database of shipwrecks within the Atlantic OCS, using existing databases, sources, and archival research. This chapter describes the efforts that went into developing the Atlantic OCS Shipwreck Database (ASD). The collected data, both existing and new, were incorporated into a Microsoft Access database modeled on the one generated for shipwrecks in the Gulf of Mexico in 2003 by Panamerican Consultants and Coastal Environments, Inc. (Pearson et al. 2003). For wrecks that had coordinates assigned to them, only those that are found within the boundaries of the Atlantic OCS were included in the database. Many wrecks are included in the database without coordinates, and many of these may be found within state waters. However, where descriptions of the wrecks made it clear that they were not within the Atlantic OCS (e.g., a ship that burned in port), these wrecks were excluded from the database.

The remainder of this chapter discusses the methods and sources used to compile the ASD. In all, there were 10,519 entries placed into the database through these efforts. Appendix 1 lists the sources used in data collection, all of which are also referenced in the ASD for the appropriate entries.

11.2. METHODS AND SOURCES

For each source consulted, a Data Source Form (DSF) was completed. The form notes the location of the source, the type of source (published, online, or archival), and other descriptive information. A DSF was completed even if the source did not provide any relevant information, which will help future researchers concentrate on the most useful sources. For each shipwreck noted in the sources, an Archaeological Resource Information Form (ARIF) was created to record the data. The forms included spaces for all of the variables in the 2003 database, including a space for notes. The forms were numbered sequentially as they were filled out to provide an identification number. Previously assigned BOEM numbers are reported under the field —Previous Survey Number.” Identification numbers assigned in other databases were retained and entered into the appropriate field of the ASD.

The sources can be divided into three major types: primary sources, secondary sources, and existing database entries. There is considerable overlap among these sources, since secondary sources derived information largely from primary documents, and existing commercial and government databases used primary and secondary documents as their source of information, along with actual reports from mariners, divers, and surveyors. Some sources were checked against the larger databases to determine if the source had already been inventoried. It was expected that some sources would not need to be recorded, since they already would have been entered into an existing database. This was rarely the case, however, as previously compiled databases did not always record all entries or all of the information provided in the sources. New ARIFs were completed for these missing or incomplete entries.

Conversely, information on shipwrecks that were already listed in existing databases was not recorded, unless the new source differed significantly from the existing entry. Slight variations in

location were not considered significant enough to add to the existing data, but large deviations in location, or inconsistencies regarding ship size, type, or cargo were recorded on new ARIFs, and the source of the information noted. It should not be assumed that all information from all sources was recorded for each vessel. Time constraints sometimes limited the data that could be effectively recorded. This is noted where applicable in the appendix of sources.

In general, photographs could not be collected from most sources because of copyright issues, copy fees, or time constraints. Instead, an effort was made to note the existence of photos in the record, by marking it in the vessel photo field of the ARIF. Photographs and images also exist for many vessels in separate collections at museums and archives. The Mariner's Museum in Newport News has an extensive photograph and image collection, but even creating a list of sunken vessels with images on file was determined to be too time consuming for the current inventory. A partial search of the index was conducted for steamships recorded in the ASD from primary sources, and a note was made on the forms of those with images on file. Based on this search, however, it was determined that checking all of the ASD would require 30–40 hours, without even viewing the images. Obtaining catalog and/or citation information for available images would likely double that time.

For the most part, if a source cited a shipwreck that appeared to be located in the Atlantic OCS project area, it was entered into the database with the information provided in the source. Data was combined for apparent duplicates, except where different or unreconcilable coordinates were provided for the same wreck or where enough information did not exist to confidently conclude that two entries with a common name were, in fact, the same vessel. The multiple references that were used for the data used in a shipwreck entry were included in the reference source field in each record. In some cases, the shipwreck was noted in other sources as well, but if that source provided no additional information (i.e., only duplicative information), it was not included as a source.

The existing databases were supplemented with shipwreck locations from secondary sources, diving books, and websites. Many of these provided Loran numbers that were converted to Lat/Long coordinates so that they would be GIS compatible. Andren LoranGPS[®] software (Version 7.3) was used to make the conversion. The major secondary sources, such as Berman's Encyclopedia of American Shipwrecks and Marx's Shipwrecks of the Western Hemisphere, were generally already included in existing databases and provided only the vaguest location information. However, a number of these types of published inventories were consulted and the information transferred to the database.

The information from primary sources varied considerably depending on the time period of the shipwreck. For the earliest period of exploration and settlement, roughly defined as the 16th and 17th centuries, primary sources such as colonial records, ships' logs, and first-hand accounts are widely scattered and difficult to use, particularly with the large geographic area encompassed by the Atlantic OCS. For the most part, these sources provide only the broadest location information, such as "off Cape Cod," or "Hurricane Shoals." Many are even less specific than that, stating only that a ship was lost "off the coast of North Carolina," "at sea," or "hasn't been heard from." If information on origin and destination is provided, it gives some indication of where a wreck might be, but searching for the wreck based on that information alone is impossible. Over time, sources provided more specific location information. Government

reports, which begin just before the Civil War with the formation of the U.S. Life-Saving Service, generally give location as a distance and heading from a known landmark. Still, even these reports are often vague, in many cases because the exact location was not documented at the time, or there were no witnesses or survivors to provide the information.

The accuracy of location information is quantified in the ASD by the “Location Reliability” field. This ranking from 1 to 4 is based on the system devised for the 2003 Gulf of Mexico shipwreck inventory (Pearson et al. 2003). Shipwrecks that have been positively located through recent survey are given a location reliability rank of 1. Those shipwrecks with specific locations provided by informants, reported in literature, or marked on a map are considered a 2. A location reliability of 3 indicates that the location is given generally rather than specifically by an informant, in the literature, or on a map. Those locations that are unreliable or vague, such as “off the coast of North Carolina” or “at sea” are ranked at 4.

The data fields developed for the 2003 inventory provided a well-developed framework for the current inventory, and in general the coding conventions used in that list were used for the ASD. Some additional codes for “Cause of Loss,” “Vessel Type,” “Were Built,” and “Nationality” were added, as necessary. These followed the two- and three-letter coding conventions used by Pearson et al. (2003).

The sources used to compile the ASD are discussed below by category and tabulated in Appendix A with the number of entries gleaned from each.

11.3. EXISTING SHIPWRECK DATABASES

Existing governmental databases formed the core of the data for the current BOEM Shipwreck Database. The National Oceanic and Atmospheric Administration (NOAA) maintains the Automated Wreck and Obstructions Information System (AWOIS), a database of wrecks and obstructions compiled from hydrographic surveys and field reports. The database is updated when new surveys are conducted (about 30–50 per year) and new wrecks are only added after they have been surveyed. Because the information is based on survey, contains detailed location information, and is updated regularly, it is one of the more reliable comprehensive databases, although older entries are often inaccurate. Unfortunately, AWOIS often lacks identifying and descriptive information on its listings.

The U.S. Navy created the Non-Submarine Contact List (NSC) for military use in distinguishing shipwrecks from submarines hiding on the ocean floor. The inventory also contains a large number of objects that are not shipwrecks, such as debris, seafloor pinnacles, and other features; however, these features were excluded from the ASD since it is known that they do not represent shipwrecks. The list is maintained by the National Geospatial-Intelligence Agency, a Department of Defense Agency that supports the National Intelligence Community through imagery and map-based intelligence for national defense, homeland security and safety of navigation. The NSC data obtained for this project included a shape file of shipwreck locations. The information from this shape file was exported and added to the ASD after entries outside the OCS had been culled.

The U.S. Navy also maintains a database entitled Partial List of Foundered U.S. Navy Craft. Ships from this source were added to the database as well.

Three commercial databases were also obtained as part of the current effort: The Global Maritime Wrecks Database, the International Registry of Sunken Ships, and the Northern Shipwrecks database. The information from these inventories is copyrighted, and thus was not included in the ASD. However, the publications are now part of the BOEM's holdings, and the information is available to qualified agency researchers. The Global Maritime Wrecks Database (GMWD) is published by General Dynamics Advanced Information Systems and includes more than 250,000 shipwreck locations worldwide. The International Registry of Sunken Ships (IRSS) is a commercial database compiled by Hugh Brown (2008) of Saskatchewan, Canada. It uses many of the sources cited here, and proved to be reasonably complete and accurate. The data is organized by state and includes numerous wrecks not in federal waters. A list of wrecks that appear to be within the OCS boundary was generated from the master list as part of the current research effort. For these two databases, all wrecks with coordinate information that falls within the Atlantic OCS were compiled, and their locations were plotted using GIS software as part of the location analysis. There were 1,364 wrecks in the IRSS and 3,505 wrecks in the GMWD that had coordinates within the project area. The Northern Shipwrecks Database, available from Northern Maritime Research of British Columbia proved cumbersome, since the data could not be copied or organized into reports by variables such as location; therefore it was not used in the location analysis.

All entries from existing databases for which locational information was available were projected in ArcGIS and those that were located within the Atlantic OCS were incorporated into the database. To create shape files, X-Y coordinates in Lat/Long decimal degree format were used to generate points for each shipwreck. Any coordinates provided in Lat/Long decimal degree-minutes or degrees-minutes-seconds formats were converted into Lat/Long decimal degrees using the U.S. Army's Corpscon software (Version 6.0). Where locational information from an original source was descriptive rather than offering actual coordinates (in the vein of "5 miles east of Cape Hatteras"), approximate coordinates were obtained from the GIS by measuring to the distance and direction described.

11.4. U.S. GOVERNMENT DOCUMENTS

11.4.1. U.S. Coast Guard, Record Group 26

The U.S. Coast Guard had its origins in the Revenue Marine Service, later the Revenue Cutter Service, a branch of the Treasury, which was established in 1790 to enforce tariffs and trade laws and prevent smuggling. Other agencies were created during the 19th century to improve navigation, provide assistance to mariners, and enforce maritime regulations, including the U.S. Lighthouse Service, U.S. Life-Saving Service, and Steamboat Inspection Service (later the Bureau of Marine Navigation and Inspection). In 1915, the Revenue Cutter Service and Life-Saving Service were merged to form the U.S. Coast Guard. In 1938, the Lighthouse Service also became a part of the Coast Guard (U.S. Coast Guard Historian's Office 2008). In 1946, the Coast Guard assumed most of the duties of the Bureau of Marine Inspection and Navigation. All of these agencies generated records related to shipwrecks, most of which are housed in National Archives repositories in Washington and at regional facilities.

Records of the U.S. Coast Guard and its two predecessors, the Life-Saving Service and Revenue Cutter Service, are part of Record Group 26 in the National Archives. Records of the U.S. Life-Saving Service include Life-Saving Station logbooks from various stations on the Eastern Seaboard dating to the 1870s and 1880s, as well as Reports of Assistance Rendered from the 1880s until the creation of the Coast Guard in 1915. These reports are held at the regional archives branches for stations in that region. Because they cover incidents handled by shore-based Life-Saving Stations, these reports largely cover wrecks that occurred within 3 miles of shore. Nevertheless, extant reports located at the branch archives in Boston (Waltham, Massachusetts), New York City, and Atlanta (Morrow, Georgia), were examined. It was determined from a preliminary search in the Life-Saving Station records at the archives branch in Philadelphia that the time required to review the records would not be productive because most of the entries were for near-shore wrecks and wrecks in inland waters such as Delaware Bay.

For the period 1913–1939, the wreck reports provided to the Coast Guard are indexed on microfilm as U.S. Coast Guard Casualty and Wreck Reports (U.S. Coast Guard 1913–1939). The card index was compiled by the Works Progress Administration and includes enough information that an examination of the actual report is unnecessary. Time constraints precluded a complete review of the index; approximately 32 hours were spent reviewing the first five-and-a-half years of the index for shipwrecks on the OCS by using the stamps on the card that noted general location (“Atlantic”) and loss to vessel (“Total Loss” for sunken or destroyed vessels). Wrecks with specific location information that indicated near shore waters, such as “New York Harbor,” “Pamlico Sound,” or “Chesapeake Bay,” were not recorded. For all potential shipwrecks on the OCS, all of the information from the cards was recorded. From that review, 130 entries (of the 494 entries from Record Group 26) were added to the database. This is a good source of information on wrecks for the early twentieth century, and likely would yield a significant number of additional entries for the period between World War I and World War II, including war losses of merchant vessels. The wreck reports appear to be the source for the annual list of American Vessels Lost, published from 1903 to the present in *Merchant Vessels of the United States*, compiled by the Coast Guard and its predecessors. Those listings are included in the ASD through 1923, after which the location information included in the published volumes becomes so vague that it cannot be determined whether wrecks were in off-shore waters.

The Life-Saving Service Annual Reports for the years 1874–1914 include tables of casualties that provide their location in relation to the nearest station. The locations in the annual reports are not as specific as those in the wreck reports themselves, so the wreck reports were consulted wherever possible.

The Coast Guard also maintains Disaster Files at its headquarters in Washington, D.C., which include incident reports, communications transcripts, newspaper clippings, and photographs of incidents involving the Coast Guard. These files mostly concern search and rescue operations during the mid to late 20th century, with some information on early 20th century shipwrecks, particularly high-profile losses. In a number of cases, the rescue operations involved a sunken or sinking vessel, and the communications records often document the latitude and longitude of where the ship was lost. These files were examined in the Coast Guard Historian’s Office to identify shipwreck locations.

11.4.2. U.S. Customs Service, Record Group 36

In 1789, the Congress authorized the creation of the U.S. Customs Service to collect tariffs on imports as a source of revenue for the fledgling federal government. The Customs Service was also charged with registering and licensing American vessels and enforcing maritime laws and regulations, including the entry of seamen and passengers to U.S. ports. Customs offices were established in 59 locations in 11 states (Stein 1992). In 1790, Secretary of the Treasury Alexander Hamilton approved the establishment of a fleet of 10 cutter ships to assist in the enforcement of customs regulations. The spartan ships were deployed to the federal customs offices on the eastern seaboard (Ross 1886).

Beginning in 1874 as a result of Congressional legislation, customs districts were required by law to report any instance of shipwrecks that resulted in property damage over \$300, loss of life, or injuries. File copies of these reports were maintained at the Custom Houses, and copies were sent to various agencies and officials at different times depending on administrative responsibilities. The agencies included the Life-Saving Service and the Coast Guard, and these copies constitute the wreck reports in the records of the U.S. Coast Guard (RG 26). The National Archives region branches have the reports from the Customs Districts in their region, and these are part of RG 36. The U.S. Customs wreck reports were examined for all of the reporting customs houses on the eastern seaboard.

11.4.3. Bureau of Marine Inspection and Navigation, Record Group 41

The Steamboat Inspection Service maintained reports of Casualties and Violations of Law, many of which contain information on vessels lost. Summaries of these reports were compiled into the annual —Proceedings of the Board of Supervising Inspectors of Steam Vessels” from 1852–1899, and —Annual Report of the Supervising Inspector-General, Steamboat Inspection Service” from 1895–1931. Incidents involving vessels that sank and that appeared to have occurred in open water or more than 3 miles from shore were recorded and added to the database.

Beginning in 1906, the Bureau of Navigation’s yearly publication Merchant Vessels of the United States listed American vessels lost, with information on the size and type of vessel, number of lives lost, the nature of the accident, the date, and the general location. The loss lists for the years 1903–1915 were compiled in volumes at the NARA, and the books are available in the NARA Finding Aids Room for the years 1917–1960. The location information in these lists was generally not specific enough to determine if the vessel was in federal waters, and since many of the losses are reported in more detail in other sources, these were not entered into the database separately.

11.5. STATE AND FEDERAL AGENCIES

11.5.1. U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) records in the National Archives include Wreck and Obstruction Files documenting reports of obstructions affecting navigation or other

maritime activity. These files document the identification, monitoring, and disposal of the obstruction by the USACE.

USACE district offices were contacted to determine if reports or surveys related to shipwrecks were available at those facilities. The New England District Office in Concord, Massachusetts, has Harbor Commission reports for the 19th century and at least one report that pertains to a shipwreck, but the contact there indicated that these would concern near shore resources. Offices in New York, Baltimore, Norfolk, Wilmington, Charleston, Savannah, and Jacksonville reported that they had no information that would be of use to the current project, since their reports dealt almost exclusively with waters within 3 miles of shore.

11.5.2. State Historic Preservation Offices

State Historic Preservation Offices in all of the states on the Atlantic Seaboard were contacted for information they might have on shipwrecks in or near federal waters (Pennsylvania and Connecticut were not included since their state waters do not abut federal jurisdiction). Although most states reported keeping a database of shipwrecks of some sort, most include few if any listings for vessels in federal waters.

Officials in Maine, Virginia, North Carolina, and Florida provided database information on shipwrecks in or believed to be in federal waters off the coasts of their states. Massachusetts, Maryland, South Carolina, and Georgia did not maintain a database, but provided previous inventories and reports that included shipwreck data and bibliographic information. Where this information was sufficiently specific and did not duplicate other sources, the data was entered into the inventory.

New Jersey and New York reported having no information on wrecks in federal waters that would be of use to the project. The Delaware SHPO did not respond in time for inclusion in the report.

Christopher Amer of the South Carolina Institute of Archaeology and Anthropology provided information on *USS Hector*, a navy collier of over 11,000 tons that sank 10 miles off Cape Romaine in a violent gale in July 1916. He also provided data on U.S. Navy vessels believed to be in South Carolina waters from a report compiled by his office.

Florida's Department of Historical Resources, Bureau of Archaeological Research maintains a site file documenting archaeological sites in state waters. A review by Vincent Birdsong, Database Administrator of the Florida Master Site File found seven shipwreck sites that lie outside of the 3-mile state waters boundary. Those seven sites are included in the inventory.

11.6. PUBLISHED SOURCES AND CONTEMPORARY DOCUMENTS

11.6.1. Newspapers and Magazines

Trade papers for the shipping and trade industries for the 19th century are an excellent source of information for lost vessels in the period prior to systematic record keeping by government agencies. The Library of Congress has a fairly complete collection of the *New York Shipping and Commercial List* (NYSCL) for the years 1815–1832. The earliest editions do not list disasters

separately, so these were scanned for entries related to lost ships. Beginning in 1818, a special section lists disasters, including losses of life, damages to vessels, and other incidents that did not result in a vessel being lost. Those entries that appeared to be relevant to potential shipwrecks within the project area were recorded and added to the database for the period 1818–1830. John L. Lochhead abstracted wreck information from the NYSCL, which is published for the Mid-Atlantic states in Joan Charles' (2003, 2004a, 2004b) shipwreck account books for the period 1821–1846. Although most of the entries in the NYSCL have only the vaguest location information, it may prove useful for matching ship names with existing but unidentified wrecks in the database.

The *Shipping and Mercantile Gazette* is a daily newspaper published in London in the 18th and 19th centuries that contains information on maritime disasters. The Library of Congress has a significant run of the *Gazette*, but because it was published daily and covers shipping worldwide, it was determined that it was not a productive source of shipwreck information for the Atlantic Seaboard. About 7 months worth of issues from 1856 were examined but only 9 wrecks were identified in 7 hours of work.

Besides these two sources, no other newspapers or magazines were systematically examined. The process was considered to be too time consuming relative to the results. However, a number of shipwrecks were identified from periodical sources through online searches, from clippings files in manuscript libraries, and from secondary sources. The Mariner's Museum in Newport News and the Boston Public Library and Massachusetts Historical Society in Boston all had collected material on shipwrecks from contemporary periodicals. For the Mid-Atlantic states, Joan Charles' books of shipwreck accounts mine a number of newspapers for information on lost vessels for the antebellum period (Charles 1997, 1999, 2003, 2004a, 2004b).

11.6.2. Lloyd's Lists

Lloyd's of London published a weekly newspaper of maritime information beginning in 1734 that included information on losses. There is an index to losses prior to 1838, as well as yearly indexes from 1838 by ship name, but these indexes are not readily available in the United States and are of limited use for locating wrecks by geographic location. The Guildhall Library in London holds a number of Lloyd's publications and manuscripts that report losses, including Weekly Shipping Index (1880–1920), Weekly Casualty Reports (1920–present), Loss and Casualty Books (1837–1998), Wreck Returns (1900–1990), and War Losses (1914–1918, 1939–1945). Reviewing these sources was impractical under the scope of work, however, since it would require a trip to England.

The Mariner's Museum in Newport News, Virginia, holds microfilm copies of Lloyd's List from 1740–1854, but they are not indexed. Editions for 1762 were examined at the University of Georgia library, which turned up very limited information. A number of entries from Lloyd's List are included in Charles' shipwreck account books for the Mid-Atlantic states mentioned above (Charles 1997, 1999, 2003, 2004a, 2004b), and these are included in the inventory.

11.6.3. Business Records

Modern marine insurance dates to the early 17th century when English law established separate Courts of Assurance and developed standardized legal language for insurance contracts. A search of manuscript collections specializing in maritime records located a number of records from marine insurance companies, but these generally did not include individual “claims” on insured properties that would provide data on shipwrecks.

Records of merchants and ship owners were also examined, with only a few returning information on shipping losses. Because the records were not concerned specifically with losses, the time required to sort through the records was prohibitive, and the information was likely to be available in other sources. They did not contain helpful information on locations of lost ships.

In general, business and insurance records were not found to be an efficient source of information on shipwrecks. However, in the case of individual wrecks, these sources could be very significant, providing information on the date of construction, size, and other features of the vessel, its cargo, crew, origin and destination, and other data.

11.6.4. Published and Manuscript Accounts

Prior to the 19th century when regular newspaper accounts are available and government records were kept for statistical purposes, data on shipwrecks come largely from written accounts in diaries, journals, and collected writings. Tales of tragic disasters and survival at sea have been popular since the beginning of sailing. The Boston Public Library and Massachusetts Historical Society have a significant number of published accounts of shipwrecks from the 17th, 18th and 19th centuries. These were reviewed for information on wrecks that might not have been included in other databases.

One of the earliest of these types of accounts found is a volume by Increase Mather, son of famed minister Cotton Mather, who used the tales of survival to illustrate both God’s terrible power and His gracious providence. Mather’s *An Essay for the Recording of Illustrious Providences* reports Anthony Thatcher’s narrative of a shipwreck off the New England coast that took the lives of much of his family, as edited by Mather. Many other similar accounts were written during the period, with varying degrees of accuracy, since the sources for many of the tales is not known or is taken from secondhand recounting (Sievers 2006). Sievers illustrates how the ends of the writer could influence the accuracy of the account, which is a significant drawback to these types of sources. However, given the task of finding isolated references to shipwrecks in historic newspapers that are not indexed, the compilations proved useful. The information that they provide should be considered unreliable and only a starting point for further research.

In the first half of the 19th century there seems to have been a surge in the number of collected volumes of shipwreck accounts, sometimes accompanied by tables listing incidents within a certain geographic region during a particular time period. These included *The Mariner’s Chronicle* by Durrie and Peck (1834), two volumes by Charles Ellms (1836, 1840), and one by the anonymous “Friend of Mariners” (1823). All of these were consulted during the present research effort.

In the late 19th century, the Procter Brothers published two volumes of vessel losses from Gloucester, Massachusetts, and surrounding communities dating back to 1830 (Procter 1873; Procter Brothers 1882). These losses were primarily to fishing vessels that plied the fishing banks of the North Atlantic. Although many of the losses were in Canadian waters off the coast of Nova Scotia and Newfoundland or in the open ocean, a significant number were lost on George's Bank, which is located about 135 miles east of Cape Cod and within the Atlantic OCS and the project area. Although location information is naturally vague, the books are an important source of information on losses outside of the merchant vessels that were tracked by insurance companies and bankers. They also provide extensive information on the history of the fishing industry in New England, statistics on the types of fish caught at different times and locations, and details of the boats, rigging, and equipment used.

11.6.5. Published Shipwreck Inventories

Interest in shipwreck diving and salvage increased dramatically in the second half of the 20th century as diving technology became widely available to recreational divers and treasure hunters. Consequently, compiled volumes of shipwrecks appeared during the period covering the entire East Coast, as well as specialized volumes for portions of the coast. Those concentrating on documentary sources for their lists provide a reference for connecting shipwrecks located through survey with known losses during the historic period. A large number of these were consulted for the current inventory (Berman 1972; Gardner 1954; Gray 2003; Kimball 2005; Lonsdale and Kaplan 1964; Marx 1981; Quinn 1979; Rattray 1973; Shomette 2007; Snow 1944).

Diving guides reference known shipwrecks, many unidentified, which can be visited by divers. In addition to published guides covering different parts of the Atlantic Seaboard, a number of dive organizations maintain websites that contain information on the location of shipwrecks. These are valuable sources that often include well-researched background information on the history of the vessel and the circumstances of its demise. In some cases, precise location information is withheld, either to guard the site from too much traffic, or to preserve the thrill of the hunt for subsequent recreational divers. Dive books covering all the states of the Atlantic Seaboard were consulted in compiling the current inventory, concentrating on those that provide detailed location information (Aqua Explorers, Inc. 2009; Association of Underwater Explorers [AUE] 2009; Barnette 2003; Berg and Berg 1991; BFDC 2007; Freitag 1997; Galiano 2009; Gentile 1990, 1992, 2002, 2003). Locations in these volumes are typically given in LORAN, but Lat/Long in various formats is also used, depending on the source of the information. All locations were converted to North American Datum 83 for the current effort to make them compatible with GIS and each other.

12. HISTORIC SHIPPING AND SHIPWRECKS ON THE ATLANTIC SEABOARD

This chapter provides a brief overview of historic shipping and shipwrecks on the Atlantic Seaboard. The purpose of this overview is to provide the historic context for the thousands of historic shipwrecks present within the Atlantic OCS.

12.1. SEAFARING DURING THE AGE OF EXPLORATION (1000–1600 A.D.)

The earliest confirmed European exploration of the coast of North America was made by Norse peoples about 1,000 A.D. Viking tales dating to some 250 years after the fact tell of expeditions by explorer Leif Eriksson that discovered Helluland, Markland, and Vinland. Eriksson and others led colonizing expeditions to the area he called Vinland, generally believed to be Newfoundland. The discovery of the Viking settlement at L'Anse aux Meadows in Newfoundland supports this theory (Nydal 1989; Wallace 2003). None of the colonies lasted more than a few years, and no further attempts were made to settle the area (McGhee 1984). It is possible that Norse explorers ventured as far south as New England during this period, but as yet, no unequivocal evidence exists to support the idea. The discovery of a Viking ship in U.S. waters would be a find of major significance.

The period of early exploration by European nations beginning with Columbus' first voyage in 1492 and continuing until the first permanent English settlement of the North American coast in the early 17th century was characterized by irregular forays by military parties seeking exploitable resources, primarily in the Caribbean, Gulf Coast, and Central and South America. From the first voyage, the process of exploration, exploitation, and colonization resulted in shipwrecks. *Santa Maria* grounded on a bank off the north side of Hispaniola on Christmas Eve 1492, becoming the first known European shipwreck in the New World. The majority of the activity during this period of exploration was undertaken by the Spanish. Englishman Henry Cabot explored the Canadian coast in 1497, but did not return from a subsequent voyage the following year, discouraging the English from significant colonization efforts until the early 17th century. There is evidence that Portuguese and French cod fishermen were aware of the fisheries off the coast of Newfoundland, possibly before Columbus' voyages, but did little to document their experiences (Keith 1988:47).

The Line of Demarcation, established by the Treaty of Tordesillas in 1494, gave Spain the upper hand in the exploitation of the Americas, granting everything west of the line to them and everything east of the line to Portugal, leaving only Brazil in the western hemisphere within the Portuguese colonial sphere. Columbus led three more voyages to the Caribbean and South America, the last in 1502–1503. He had been granted exclusive rights to the Americas, but after his third voyage, the Spanish government began to authorize other explorers. Four expeditions were sanctioned in 1499, with at least seven more over the next five years. These exploratory voyages were comprised of fleets of as many as 20 ships. In many cases the actual number of ships was not documented, since only the principal ships were discussed in the records. From 1499 to 1520, at least 50 ships were lost in the Americas (Keith 1988:50, 66–67). According to Keith, besides the four ships of John Cabot that did not return from an expedition to the coast of New England, it is not believed that any of these vessels were lost on the Atlantic Seaboard. The

earliest known loss on the Atlantic Seaboard was an unidentified ship in the fleet of Spanish explorer Vasquez de Ayllon that was lost off Cape Romain, South Carolina, in 1520. Ayllon also lost a caravel off of Cape St. Helen, believed to be around the mouth of the Savannah River, in 1525 (Marx 1981:195).

In 1513, Ponce de Leon found his way to Florida, bringing attention to the Gulf Stream flowing from the Gulf of Mexico northward between the Bahamas and Florida and providing swift passage back to Spain. Following Cortes' conquest of Mexico in 1519, the systematic plundering of its riches began, and Spanish fleets began to regularly use the Straits of Florida for the voyage back to Spain, a practice that would continue for nearly 300 years. Loaded with gold and silver, the ships would depart from Spanish outposts in Central and South America and rendezvous at the colonial settlement of Havana on the north coast of Cuba, then continue on to Spain via the Gulf Stream. Their course took them past reefs and shoals along the Florida Keys and the North Carolina coast, where navigational errors or hurricane winds could send them crashing onto shore or cause them to founder and sink. Using primitive navigation tools and driven by greed to overload their boats and push their luck, Spain lost an estimated 5–12 percent of its fleet yearly during the period from 1500 to 1700 (SAI 1981:III-26).

The Spanish merchant vessel *San Anton*, a 100-ton caravel under the command of Gonzalo Rodriguez was lost in the Florida Keys in 1521, perhaps the first of many Spanish "treasure ships" to be lost off the Atlantic coast while sailing from Cuba to Spain. The lure of these treasure wrecks has contributed to extensive research on shipwrecks of the period, not all of which is made public by the investigators. The research has resulted in the discovery of a number of these ships, including *Nuestra Senora de Atocha*, located by Mel Fischer in 1985, and the ships of the 1715 and 1733 disasters that sent dozens of ships down in the Florida Keys and near Cape Canaveral respectively (Barnette 2003; Marx 1987). These discoveries have further fueled treasure hunting divers, who often focus on recovery at the expense of scientific investigation.

Spain dominated trade in the New World during the 16th and 17th centuries, although the wealth arriving each year in Madrid prompted its rivals England and France to begin exploring the New World as well, in an effort to break the Spanish stranglehold on trade. In addition, the vast treasures crossing the Atlantic made alluring targets for naval ships and privateers seeking to disrupt trade and capture bounties. Each new war in Europe led to increased piracy and threats to ships sailing in the Western Hemisphere. Beginning in the late 16th century, English captains of private merchant vessels were granted letters of marquee that permitted them to plunder Spanish ships as privateers. Second cousins John Hawkins and Sir Francis Drake were among the British sea captains who engaged in piracy against the Spanish fleet in the second half of the 16th century. To counter these threats, the Spanish began to ship their treasure in convoys or flotas, with the main cargo being heavily guarded by Spanish war galleons. There were two main fleets: the Nueva España Flota, which picked up its cargo at Vera Cruz, Mexico, and the Tierra Firme Flota, which stopped at Porto Bello in Panama and Cartagena in Colombia. The flotas left Spain together yearly for the colonies, then split up to call at their respective ports. Ideally, the fleets would reconvene at Havana, Cuba, to prepare for the Atlantic crossing and return together (Smith 1988:85–86).

While the flotillas provided protection from attack by other vessels, they could not protect the Spanish treasure from dangerous reefs and shoals, or from the threat of hurricanes, which

swept through the Caribbean and the east coast of North America with regularity during the late summer and fall hurricane season. With the boats traveling together, unlucky timing of a voyage could mean the loss of dozens of ships in a single storm. Such disasters befell the flotas of 1554, 1622 (of which *Atocha* was a part), 1623, and 1632. *Santa Margarita* was lost off the coast of Florida in 1595 with a cargo estimated at \$3 million in gold and silver. The loss of over a dozen Spanish ships off the Florida Keys in a 1733 hurricane was one of the last disasters to befall the flotas, capping over 200 years of massive losses (Lonsdale and Kaplan 1964:58).

The Spanish established the first permanent European settlement in the U.S. at St. Augustine, Florida, in 1565, expanding northward in the late 16th century into Georgia and the Carolinas. Between 1562 and 1588, settlements were established at San Pedro (Cumberland Island) and Santa Catalina (St. Catherines Island) in Georgia, and Fort San Marcos in Port Royal, South Carolina. Although the goal of the settlements was to exploit local resources, missions were also established to convert the local Native Americans to Catholicism. Eventually, Franciscan monks established more than 100 missions in the Southeast. The east coast of Florida south of St. Augustine remained largely uninhabited by Europeans, with the exception of a fortified watchtower at Matanzas Inlet, until the 17th century (SAI 1981:III-26–28).

Increasingly, Spanish ships carried civilians, trade goods, and slaves to supply its outposts. The Spanish conquistadors had routinely enslaved the Native Americans of Central and South America to work in the mines and perform other labor, but a decline in population from warfare and disease resulted in a shortage of labor in the mid-16th century. The Portuguese had been securing slaves from Africa and transporting them to Portugal and its possessions in the Eastern Atlantic since the 1440s, and Spain soon followed in the practice in competition with its rival. The introduction of slaves to the New World was gradual and sporadic, however, as the importation of slaves was seen as potentially undermining the use of Native Americans for labor. The earliest African slaves arrived in the New World as servants to the explorers or as laborers on ships (Thomas 1997:54–76, 90–92).

The native groups were considered inferior slaves to Africans, and as their populations declined, King Ferdinand began to authorize small numbers of slaves to be sent to Hispaniola to work in the gold mines, beginning in 1510. The importation was closely regulated, with perhaps 50 per year being permitted. The Spanish colonists were soon clamoring for more to work on the sugar plantations that were being established on Hispaniola, and in 1518, the recently crowned King Charles I (later Charles V, Holy Roman Emperor) issued a license to import 4,000 or more slaves to the Spanish colonies. Sugar cane would prove to be the life blood of the Caribbean and the principal driver of the Atlantic slave trade. By 1537, when Hernando DeSoto was granted permission to bring 50 slaves on his expedition to the mainland of North America, thousands of Africans had already been transported from Europe and Africa to the New World (Thomas 1997:92–103).

The Portuguese, British, French, and Dutch all eventually developed sugar plantations on their claims in the Caribbean and South America, and all were involved in the slave trade to varying degrees. Over a period of more than 300 years, approximately 10 million Africans were transported from Africa as slaves. The vast majority of this number went to Brazil and the West Indies, but about 645,000 were brought into the British colonies in North America and later the U.S. to labor on rice, indigo, and cotton plantations in the southern colonies. Many of these

slaves were transferred there from the West Indies. To maximize profits, slave traders packed their human cargo into ships under deplorable conditions. It is estimated that one in eight slaves died en route and about one-third died in the first three years, ensuring a steady demand (Preston and Natkiel 1986:54–55). Slaves were also imported into the Mid-Atlantic and New England colonies, although in smaller numbers, to serve primarily as household servants and general laborers. Nevertheless, large dairy and cattle farms in Rhode Island and Connecticut employed slave labor, and by the mid 18th century, the black populations of these colonies numbered over 5,000 each (Russell 1976:196).

In the late 16th century, France began an effort to colonize North America to provide a haven for French Protestant Huguenots. The colonies would also provide a base from which they could launch attacks against the Spanish flotas. Two French settlements actually predated St. Augustine, which the Spanish had established in response to the threat of the French colonies. In 1562, French explorer Jean Ribault attempted a settlement at Port Royal, South Carolina, called Charlesfort, but the effort was a failure. Some of the settlers from that venture relocated southward under René Laudonnière and established Fort Caroline, at the mouth of the St. John’s River, Florida, in 1563. Most of the inhabitants of this colony were slaughtered by Pedro Menéndez de Aviles, who had established St. Augustine to protect the Spanish claim to Florida. After that time, the French concentrated their efforts on the Canadian provinces and the lucrative fur trade there (SAI 1981:III-26).

12.2. SHIPPING AND SEAFARING IN THE ENGLISH AND DUTCH COLONIES OF THE ATLANTIC SEABOARD (1600–1884)

Soon after the abortive French colonies on the Southeast coast, English and Dutch explorers began to scout the Eastern Seaboard for favorable locations for colonial settlements. The vast coastline north of the Spanish missions was first explored by John Cabot in 1497 and by Italian Giovanni da Verrazano, sailing under a French flag, in 1524; but it was not until Sir Walter Raleigh founded the Roanoke Colony in 1585 that any effort was made to establish a permanent settlement. Raleigh returned to England for supplies for the struggling colony, only to return to find that all of the inhabitants had disappeared without a trace. James Smith established the first successful English settlement in the New World at Jamestown, Virginia, in 1607. The survival of the settlement was by no means assured, however, and colonists nearly perished in the winter of 1609–1610. The cultivation of tobacco in the Chesapeake proved to be a lucrative enterprise, and by the mid-17th century the region was thriving (Steffy 1988).

The purchase of 20 “negroes” from a Dutch privateer in 1619 by the Jamestown colony is the first mention of the slave trade in the English colonies. In 1624, a census of the settlement noted 22 blacks, some likely personal servants of arriving colonists. By the late 1620s, reports of large numbers of slaves arriving in Virginia can be found. The owner of *Benediction* complained in 1629 of the seizure of his ship, which was engaged in its “accustomed trade” with 180 slaves by a French vessel (Thomas 1997:174–176).

Large plantations were established in the estuaries and tidal rivers of the Chesapeake Bay, and a regular flow of English ships brought settlers and manufactured goods, while returning to England with tobacco and furs. A regular trade in slaves and rum from the West Indies built up

the plantation landings, which became mini-*entrepôts* that enriched the aristocratic families of Maryland and Virginia (Isaac 1982:16, 32–33).

Soon after the establishment of Jamestown, Englishman Henry Hudson, sailing for the Dutch East India Company, explored the river that now bears his name. In 1610, the Dutch established a trading post on the island of Manhattan from which to engage the Native Americans in the fur trade. However, it was not until 1624 that the permanent colony of New Amsterdam was established on Manhattan Island under the oversight of the newly established Dutch West India Company. The Dutch soon established settlements up the Hudson River to Albany (called Fort Orange at that time), and engaged in extensive trade with Europe and the English colonies, which took advantage of political turmoil in England to skirt trade regulations. The Netherlands led the world in global trade by the 1650s (Steffy 1988:107, 116). Among the cargo of Dutch ships were African slaves, many of them taken from Portuguese ships seized in the ongoing conflict between the two competing shipping powerhouses in the first half of the 17th century. Slaves were sold in New Amsterdam as early as 1625, and the Dutch West India Company in 1629 promised to bring as many slaves as possible to the colonists (Thomas 1997:170).

Tensions between the English and the Dutch escalated after the restoration of Charles II to the throne, and in 1664, a British fleet forced the surrender of New Amsterdam without a shot being fired. The Dutch briefly regained control of New Amsterdam in 1674 during the Third Anglo-Dutch War, but it was recaptured by the English the following year.

About the same time that New Amsterdam was established, refugee Protestant groups from England were arriving in New England. Plymouth in 1620, Salem in 1626, Massachusetts Bay in 1628, Providence in 1630, and Hartford in 1635 were among the earliest settlements there. A regular supply of provisions, livestock, and manufactured goods from England was needed to support these colonies in the early years, with little produced for the return voyage. By the last quarter of the seventeenth century, however, the New England colonies were producing corn, flax, potatoes, salted meat and fish, livestock, and a wide variety of forest products (lumber, ships' masts, staves, pitch, and tar) for export to Europe, the Caribbean, and even Africa. A strong coastal trade also developed (Russell 1976).

An adequate inventory of sailing ships was needed to facilitate this trade. Although the colonies were rich with materials for shipbuilding, skilled workers and tools were lacking in the first half of the sixteenth century. However, an array of small, coastal vessels was constructed in New England and to some extent in the Chesapeake Bay. These included flats, skiffs, sloops, cutters, shallops, and pinnaces. Fishing fleets were also needed to harvest the bounties of the North Atlantic and Chesapeake Bay. Fishermen established winter camps along the coast of Maine in the 1600s, many of them located on islands for protection from hostile native groups. Ships were often constructed or repaired in these camps during the winter. Most ocean-going vessels supplying the English colonies during the early 17th century were manufactured in the motherland, with local shipyards dedicated primarily to maintenance and repair. By the mid 1600s, with the supply unable to meet demand, however, Massachusetts Governor Winthrop instituted a number of measures to encourage shipbuilding. Between 1641 and 1646, at least six ships of more than 200 tons and several smaller ones were built. Restrictions on trade enacted in England only encouraged smuggling, which in turn benefitted the shipyards. By the late 17th

century, Boston had become the leading ship-builder, turning out an average of 15 ships a year (Bauer 1988:26, 31–32; Steffy 1988:116).

With the New England and Chesapeake Bay colonies achieving stability and returning profits to their investors and Spanish power waning on the South Atlantic coast, a number of new ventures were attempted in the Mid-Atlantic and Southeast in the second half of the 17th century. New colonies were founded in North Carolina (1653), New Jersey (1664), South Carolina (1670), and Delaware (1681). In 1686, Spain withdrew from all of its settlements and missions north of the St. Mary's River. Overland travel along the Atlantic Seaboard was difficult in these regions because of low-lying floodplains and large estuarial waters. Consequently, coastal and inland water travel was critical to development. The Carolina settlement of Charles Town served as the shipping and administrative center for the river plantations growing rice, indigo, and later cotton. Charleston traders also ventured far into the interior to trade with Native American groups for deerskins. The demand for deerskins was so high in England that the deer population in the Southeast was nearly wiped out. Beginning in 1698 and continuing until the American Revolution, 50,000–100,000 skins were shipped annually from Charleston alone. Charleston's pre-eminence as the leading southern port was eventually challenged by Savannah, which was matching the South Carolina port's exports in deerskins by 1768, and also shipped large quantities of rice and naval stores (Braund 1993:97–98).

During the 18th century, Spanish colonial power in the Western Hemisphere continued to wane, although Spain clung stubbornly to Florida, Mexico, and three of the four largest islands in the Caribbean (Cuba, Hispaniola, and Puerto Rico) during the first half of the century. Meanwhile, the British gained control of Jamaica and many of the islands of the Lesser Antilles, while strengthening their position in North America with the establishment of the Georgia colony in the 1730s. The ongoing colonial feuds encouraged piracy on the high seas, and the early 18th century is regarded as the heyday of Caribbean piracy and illegal trade. Piracy was not, however, confined to the Caribbean. Pirates were active on the Atlantic coast as well, using the isolated inland waters of the barrier islands as hideouts (SAI 1981:III-36). In 1984, the wreck of the pirate ship *Whydah* was discovered 500 feet off Marconi Beach, Cape Cod, Massachusetts. Wrecked in a storm in 1717, *Whydah* was the flagship of the pirate —Black Sam" Bellamy. To date, it is the only confirmed pirate shipwreck that has been discovered. The supposed wreck of *Queen Anne's Revenge*, the flagship of famed pirate Blackbeard (née Edward Teach) lost in 1718, has been recently located at the mouth of Beaufort Inlet in North Carolina. Both ships were former slave vessels that had been captured, and shackles used during its slave days (and likely its pirate days, as well), have been recovered from the *Whydah* (Expedition *Whydah* ca. 2008; *Queen Anne's Revenge* n.d.).

British privateers weakened Spain's sea power, even as Spanish flotillas continued to ship gold and other goods from Mexico through the Straits of Florida. In 1714, all but one of a fleet of 11 ships were smashed in the shallows off Sebastian Inlet south of Cape Canaveral. In 1733 a convoy of 21 ships, including three armed galleons and 18 merchant ships were struck by a hurricane off the Florida Keys while on a return voyage to Spain. Only one of the ships was able to return safely to Havana. Portions of these ships and their cargoes have been recovered, but likely many still remain. The Spanish conducted their own salvage operations after these losses, employing drag nets and Native American and African-American free divers to recover the lost cargo (Preston and Natkiel 1986:69; Smith 1988:95–103).

The success of colonialism and its attendant mercantile economic policy during the 18th century contributed to a golden age of seafaring among European nations. Ship design became more sophisticated and advances in engineering, navigation, and meteorology made voyages increasingly successful, lining the pockets of those men who controlled the lucrative contracts issued by the crown heads of Europe (Schlesinger 1917). By the early 18th century, nearly 400 ships were clearing Boston yearly for Britain, and the number continued to increase. New York, Philadelphia, Newport, and Providence would follow in the mid-18th century, with 300 or so ships a year arriving from foreign ports (Bauer 1988:38–42).

England and France struggled for control of the North American continent during the 18th century, sparking a series of wars between the two powers and their Native American allies. Control of the seas was critical in these colonial conflicts, since the transport of troops and supplies by water was more efficient than overland travel in the undeveloped backcountry. Queen Anne's War (1702–1713) was fought primarily in the border area between the English and French colonies, but the hostilities did affect shipping on the Atlantic seaboard, as the French fortification at Louisbourg on Cape Breton Island provided a base for the French navy and privateers to harass English merchant vessels and fishing fleets. The Treaty of Utrecht, which ended the war, provided the English with a permit to import slaves to the Spanish West Indies, catapulting the country into the slave trade (Crisman 1988).

In King George's War (1744–1748), a group of New England colonists organized an expedition against Louisbourg, utilizing merchant vessels and fishing boats outfitted with guns to bombard the fortress. With the Royal Navy blockade preventing the resupply of the fort, the French eventually were forced to surrender. England was also at war with Spain during this period, a conflict known as the War of Jenkins' Ear in the colonies. The main theater in that war was the coast of Georgia, where England had recently established a colony. Led by Georgia colony founder and accomplished sea captain James Oglethorpe, the English raids on Spanish positions south of Savannah were successful in providing breathing room for the Georgia colony to prosper (Crisman 1988; Spalding 1977:30–33).

The uneasy truce following King George's War would collapse soon after, drawing the world's colonial powers back into conflict for control of world trade. The French and Indian War (1755–1763) was the North American component of the Seven Years' War, which saw superior British sea power eventually crush the French and their Spanish allies in the Gulf and North America. The fall of Quebec in 1760 effectively ended the French resistance in North America, and Canada was transferred to Britain under the terms of the Treaty of Paris in 1763. The Spanish relinquished Florida under the terms of the treaty as well, and it remained a British possession until after the American Revolution, when it was returned to Spain (Crisman 1988).

Great Britain became a major player in the slave trade in the 18th century, in large part because of a provision in the Treaty of Utrecht in 1713 that granted the country a license to ship slaves to the Spanish colonies in the West Indies. In the 1720s, Great Britain brought about 100,000 slaves to the New World, mostly to Panama, Buenos Aires, and Cartagena, as well as to the British colony of Jamaica. About 10,000 slaves were brought to mainland North American colonies such as Virginia and South Carolina. Another 40,000 arrived in the 1730s. Slaves were also brought into Boston, New York, and Philadelphia, although in smaller numbers. Eltis (2001) estimates that 361,000 slaves were brought to British North America before 1868. Colonial

merchants and shipping concerns gradually became involved in the slave trade during the 18th century. The majority of these were New Englanders, being more heavily invested in shipbuilding and overseas trade. Rhode Island was a major center for the slave trade, having good harbors and a strong shipbuilding industry. Newport and Providence were important stops in a triangular trade that brought slaves to the West Indies, sugar to New England, and rum to Africa (Thomas 1997:244, 246, 259–261).

It is difficult to estimate the number of slave ships that may have been lost along the Atlantic seaboard, since even during the 17th and 18th centuries, much of the slave trade was clandestine. Two lost slave ships, *Henrietta Marie* and *Guerrero*, have been identified off the Florida Keys. *Henrietta Marie* was wrecked on New Ground Reef in 1700 after dropping off a cargo of 190 slaves in Port Royal, Jamaica. *Guerrero* was engaged in illegal slave trading and became stranded on Carysfort Reef while trying to elude a British naval schooner, H.M.S. *Nimble*. *Guerrero* did not sink immediately, but 41 of the 561 captives aboard were drowned when the holds filled with water (Barnette 2003).

Nurtured by mercantile laws intended to spur trade, the triangular trade in the Atlantic reached its peak in the 18th century. With the waning of Dutch and Spanish power in the Western Hemisphere, the British rose to dominance in the global shipping industry. The British government sought to control trade with the colonies to the benefit of the mother country by requiring that ships calling at English ports be owned and manned by Englishmen and that shipments between the colonies be routed through England, but these regulations were largely ignored. Although the majority of ships in colonial ports were British-owned, hundreds of American-built and -owned vessels were engaged in local and transatlantic trade. American merchant families and plantation owners rose to political and social prominence during the period, forming the cultural foundation for the American Revolution (Steffy 1988:119).

Each region of the colonies developed its own export specialties and import needs. The New England colonies exported beef, forest products, grain, fish, and rum while importing manufactured goods, sugar, molasses, and metals. The Mid-Atlantic colonies produced fish, tobacco, and furs for export, while importing manufactured goods and slaves. In the South, tobacco, indigo, rice, furs, naval stores, and deerskins were the chief exports (with cotton becoming important in the latter part of the period). The South imported manufactured goods from England, sugar from the West Indies, and slaves from the West Indies and Africa (Preston and Natkiel 1986:68). In addition to these major commodities, all manner of goods were shipped across the Atlantic and between the colonies, including coffee, tea, spices, salt, produce, table- and glassware, fabrics, tools, tin- and brassware, ivory, and precious stones.

12.2.1. The Development of Shipping and Shipbuilding in Colonial America

The vigorous colonial trade gave rise to the great seaports of the Atlantic Seaboard. On the eve of the American Revolution, Philadelphia was the largest city, with a population of approximately 40,000. New York was a bit more than half that size, with a population of 25,000. Boston, Charleston, and Newport all boasted more than 10,000 residents. For each of these cities, maritime trade was its lifeblood, and each developed shipbuilding industries. The British government encouraged shipbuilding in the colonies, and in the New England states the large number of artisans, the high demand for sailing vessels, and greater emphasis on industry led to a

burgeoning shipbuilding industry. Philadelphia and Boston dominated in the construction of larger vessels, while New England ports like Essex and Gloucester, Massachusetts, Providence, Rhode Island, and Mystic, Connecticut, produced smaller schooners and sloops for fishing or coastal and Caribbean trade. By the start of the American Revolution, 30 percent of the British merchant fleet was from colonial shipyards and there were an estimated 2,000 American ships engaged in trade. It was these merchant vessels that would be pressed into service in the Revolution and form the basis of the U.S. Merchant Marine (Bogart 1912:56; Butler 1997:8–9; Steffy 1988:128).

Despite the vigorous trade and the vast supply of raw materials for their construction, few ships were built in the South until about the mid-18th century. With an adequate supply of merchant ships from England, along with an increasing supply from New England, southern shipyards concentrated on making repairs rather than fabrication. Vessels that were built were generally sloops and schooners involved in the coastal trade. Of the 229 vessels trading in North Carolina in the period from 1710–1739, less than 17 percent were built there (SAI 1981:III-39).

The shipping trade carried the potential for great profits for ship owners, but was a risky business during a period of widespread piracy, primitive navigation, and sailing ships that were at the mercy of Atlantic storms, Caribbean hurricanes, and poorly-charted hazards. In addition to these catastrophic threats, there were inadequate crews, bureaucratic delays in overseas ports, uncertain markets, and impatient investors. The potential for huge losses was ever present, and as many fortunes were lost as were won. The cost of constructing a large ocean-going vessel with a capacity of 100 tons was a significant investment, one that could result in a total loss in the event of a cabin fire, a navigational miscalculation, or a fierce storm. During the 18th century, the practice of insuring vessels and cargo became more widespread and organized. In the 1690s, Edward Lloyd began to publish a weekly newsletter in London reporting on the arrival and departure of ships to attract mariners, merchants, and bankers to his coffeehouse on Lombard Street. The newsletter also reported on shipping losses such as ships not heard from or coming into port damaged. The paper came to be called Lloyd's List and has been in continuous publication since. Starting in 1735, the list was published twice weekly. Lloyd's Register of Shipping, a separate yearly inventory of British and foreign merchant ships, is a good source of information on the size, construction, and condition of vessels, as well as the owner, captain, home port, and other valuable data (SAI 1981:III-40). Unfortunately, however, until recently the registers did not include a record of losses, which would have been of great use for documenting early American shipwrecks.

To mitigate potential losses, 18th century merchants and shipping interests began to invest in aids to navigation and protection for mariners. The first lighthouses on the Atlantic Seaboard appeared in the early 18th century. The Boston Light on Little Brewster Island in Boston Harbor was the first of these, built in 1716, with others built in Massachusetts, New York, and Maine. These were largely funded by states and cities that hoped to make their harbors more attractive to mariners. The Sandy Hook lighthouse protecting the entrance to New York harbor was completed in 1764 and is the oldest lighthouse in the U.S. still in operation. In 1789, the U.S. Lighthouse Service was created as a part of the Department of Treasury, the first public works agency of the federal government. The construction, maintenance, and operation of all lighthouses in the U.S. fell to the new agency. In 1791, the Portland Head lighthouse in Maine, originally funded by the state of Massachusetts, became the first lighthouse completed by the

federal government. A dozen more were constructed over the next decade (Lighthouse Depot n.d.; Smithsonian Institution n.d.).

Later, in the 19th century, lightships were deployed at dangerous shoals, guiding ships along the coast and into port where lighthouses could not be built. Between 1820 and 1952, 179 lightships were built for use in American waters. These vessels, both manned and unmanned, often became casualties of storms themselves, and were thus added to the inventory of submerged historic vessels (Delgado 1989).

Working on ships was extremely dangerous, and in 1742 the Boston Marine Society was formed to support the families of captains disabled or lost at sea. The society was the first organization of its kind in the world. The Humane Society of Massachusetts was established in 1786 and constructed rescue stations along the New England coast, as well as shelters for stranded mariners (Boston Marine Society 2001; Humane Society of the Commonwealth of Massachusetts 2009).

In addition to physical protections for their ships, colonial merchants sought to maximize their profits by ensuring full-capacity loads for each leg of a voyage, securing reliable markets, and minimizing fees and duties. They soon chafed under the restrictions on trade imposed by the British Crown, which sought to wring as much benefit from the colonies as possible. It was, in part, the growing power of these merchants, and Great Britain's futile efforts to control them and their profits, that brought on the American Revolution (Bauer 1988:44–49; SAI 1981:III-42).

12.2.2. Naval Action in the Revolutionary War

At the outbreak of the American Revolution, the British had the most powerful navy in the world, while the colonies had none. Yet sea power was to play a decisive role in the conflict. The British wasted considerable time in attempting to subdue the revolt on land, and it was not until the war was in its fifth year that the strategy shifted toward blockading the coast to prevent supplies from coming in and the exports that were sold to fund the war effort from going out. Against the mighty British ships-of-the-line, commonly fitted with 74 guns, and a vast fleet of supply and support ships, the Continental Congress cobbled together a collection of refitted merchant ships of 10–20 guns, eight new frigates of 24–32 guns (13 were originally authorized), and varying quality sloops and schooners purchased from merchant shippers. The new frigates were generally well-made and fast, as evidenced by the admiration bestowed on them by the British navy, but all were scuttled, destroyed, or captured, in large part because of incompetent and inexperienced captains and poor strategic planning. The Continental Congress ordered several more ships in 1776, including three ships-of-the-line of 72 guns, but only one of these was built, and it was not launched until the war was effectively over, in 1782 (Chapelle 1949; Sands 1988). None of the wrecks of these original frigates are known to be in Federal waters.

Although the frigates ordered by the Continental Congress had little impact on the war, the sloops, schooners, brigs, and brigantines that were purchased, pressed into service, or operated as privateers proved to be of use to the Continental cause. Fast, maneuverable schooners, a ship design indigenous to the American colonies, were able to harass British supply boats, slip past blockades, and serve as packets for re-supplying the Continental army. In addition, smaller

vessels such as galleys, gunboats, and barges were used on inland waterways (Chapelle 1949; SAI 1981; Sands 1988).

The individual colonies also contributed vessels to the Patriot cause. Much of the naval action during the war took place south of the Mason-Dixon Line, as the British shifted their emphasis to stifling trade and restricting the Continental Navy's ability to resupply troops on land. The South Carolina State Navy was small and undermanned, but was very active in the defense of Charleston and the coast of South Carolina. Between 1776 and 1779, South Carolina's navy was able to capture 35 ships in the Carolinas, Florida, and the West Indies. Its fleet included at least four vessels acquired from France. Three of these French-made ships, as well as four Continental Navy frigates, and four other vessels were scuttled at the mouth of the Cooper River and their masts joined by a boom to impede the British squadron, during the siege of Charleston in 1780 (SAI 1981; Watts 1995:19).

In North Carolina, the state navy was primarily concerned with protecting Ocracoke Inlet, which was the only reliable access to Pamlico Sound and important supply lines for the Continental Army. The dangerous waters of the Outer Banks took their toll, however, as the ship *Caswell* and the sloop *Independence* were lost during these patrols (SAI 1981:III-44).

Perhaps the most potent maritime weapons of the Revolutionary cause were the privateers, private ship-owners granted letters of marque permitting them to outfit their boats with guns and seize the ships and cargoes of the enemy. In all, some 600 British ships were seized during the course of the war, although in many cases the privateers simply sold the captured goods back to the British (Chapelle 1949; SAI 1981; Sands 1988).

Although the Continental Navy, aided by privateers, was able to secure isolated victories against the Royal Navy, their efforts were ineffective in breaking the British hold on the coastline. The state navies were generally unable to protect the coastal ports, which fell one-by-one to the British forces, beginning with New York in 1776, where a massive British fleet deposited 12,000 British regulars and 9,000 Hessian mercenaries to take control of the city and its harbor. The Penobscot Bay expedition in 1779 was an ill-fated American effort led by political appointee Dudley Saltonstall that maneuvered itself into a trap, with the result that all of its ships were scuttled, run aground, destroyed, or captured. None of these wrecks are known to be in federal waters (Sands 1988).

One of the largest naval battles of the war, and its most decisive, was the Battle of the Chesapeake, also known as the Battle of the Virginia Capes, in September 1781. A British fleet under Sir Thomas Graves sailed from New York to deliver supplies to General Cornwallis, who was hemmed in at Yorktown, Virginia, by General Washington's forces. A French squadron, under the command of the Comte de Grasse had arrived to protect the entrance to Chesapeake Bay. The British fleet caught the French at anchor behind Cape Henry, but did not attempt to enter the bay, instead drawing up in a line of battle off the coast. Only the leading lines of the squadrons were engaged in the fight, which ended in a draw, and after several days of maneuvering, Graves was unable to break the French blockade. Cornwallis was consequently forced to surrender at Yorktown after a brief siege (Preston and Natkiel 1986:80).

12.3. THE RISE OF THE UNITED STATES AS A MARITIME POWER (1790–1865)

Although the defeat of Cornwallis at Yorktown marked the effective end of the American Revolution, the settlement would not be completed until the European powers negotiated the Treaty of Paris in 1783. The importance of naval power to the Patriot victory was not regarded well enough to induce the newly organized United States of America to authorize its own navy after the war. There was little money in the Treasury, and even after the strengthening of the federal government under the new Constitution, there was little effort to develop a navy. Consequently, ships flying the American flag were subject to seizure by pirates and privateers. Particularly troublesome were the Barbary Coast pirates of North Africa, but the continuing European wars meant that an American ship might be boarded by British, French, or Dutch ships, its crew impressed into service on meager pretenses, or its cargo seized as contraband.

12.3.1. The Birth of the U.S. Navy

By the late 1790s, the need for some sort of navy had become obvious, and in 1794 Congress authorized the construction of six frigates. However, subsequent peace treaties slowed the progress on the ships, and only three were launched in 1797. Among these was the 44-gun *USS Constitution*, the only surviving ship from the first U.S. Navy. While the construction of these vessels was going on, the wars in Europe escalated the threats to U.S. merchant ships. The French Revolution increased the number of detentions and confiscations, and by 1798, the issue had reached the point of undeclared war. Consequently, Congress authorized the construction of more warships, as well as funds to complete previously contracted vessels that had languished in the yards. Five new frigates of 28–36 guns were launched in 1799—*Boston*, *New York*, *Philadelphia*, *Essex*, and *John Adams*. These frigates were constructed by subscription at various shipyards on the east coast, the first three in their namesake ports, *Essex* in Salem, and *John Adams* in Charleston (Chapelle 1949:126–135).

Although the ships were strong and of sound design, they were subject to frequent “improvements” by the Navy and their individual captains that compromised their effectiveness. Some were fitted with more guns than they were rated for initially, adversely affecting speed and maneuverability. To compensate for the added weight of the guns, captains often called for longer spars to carry a greater amount of sail, hoping to increase speed, but often exceeding the capacity of the hull design. A number of these ships were subsequently modified to improve their versatility, and the feedback of officers led to a shift toward smaller ships in the first part of the 19th century (Chapelle 1949:150, 168–169).

The Navy also acquired a number of cutters on loan from the Revenue Department, which operated as U.S. Customs Service cutters, the precursors of the Coast Guard. The Customs Service, created in 1790, had received nine small schooners and one sloop. These ships proved to be too small, and 11 double topsail schooners were built by subscription in 1797. The Navy took nine of these into service, returning six to the Revenue Service in 1799 (Chapelle 1949:146–147).

The Navy was scaled back in 1801 after a treaty was established with the French in which U.S. neutrality rights were accepted and obligations originating during the American Revolution were terminated, but the issue of freedom of the seas was far from settled. After disposing of a

number of useful schooners and other small vessels, the Navy was left with just 13 large frigates, only six of which were maintained for active duty. The Barbary pirates continued to harass American merchant vessels, but the Jefferson administration hoped that privateers could provide assistance to the meager force that was sent to Tripoli. It soon became clear, however, that cruiser class vessels were necessary, and in 1802 Congress appropriated funds for four vessels of no more than 16 guns, as well as 15 small gunboats. The use of single-cannon gunboats of less than 100 feet in length for harbor and river patrol was developed by the French and proved attractive to the U.S. because of the relative economy of constructing these vessels. An additional 25 gunboats were ordered in 1805, 50 more in 1806, and 188 in 1807, although not all of these were built (Chapelle 1949:179–219).

12.3.2. American Shipbuilding Comes of Age

While the Navy was shifting to smaller vessels and showed little interest in innovation during the early 19th century, commercial shipbuilders were developing increasingly sophisticated designs. Brigs and schooners were made larger, with greater speed and carrying capacity. Improvements were also made to rigging and spars that made them lighter and stronger. The demand for American-made schooners was high, and many were purchased by foreign traders, to the dismay of those concerned with protecting American interests. The Jefferson Embargo, instituted in 1807 following the British firing on USS *Chesapeake*, worked to depress shipbuilding in the North, however, while encouraging illegal trading. Southern shipyards fared better, turning out fast ships for the contraband trade that took advantage of the less well-regulated southern ports (Chapelle 1949:243).

With its navy neglected and its merchant marine struggling against the embargo, the U.S. was in a poor position to assert its maritime rights. The limited scope of the U.S. Navy at the outbreak of the War of 1812 can be attributed to a conservative approach that emphasized coastal defense using gunboats, as well as a resigned acceptance of British naval dominance. The suggestion that the fledgling country could dictate the maritime policy of the indomitable Royal Navy was met with derision. The cost of matching British sea power was considered prohibitive. However, following a series of attacks on American merchant vessels, the cost of inaction became evident. Had the U.S. deployed a sufficient navy before the war, it might have avoided the conflict altogether. Instead, it would cobble together a fleet from its merchant marine, the Revenue Service, and a series of hastily-built cruisers, while getting early support from privateers (Chapelle 1949:150, 235, 240–244, 254).

The main theater of the War of 1812 was on the Great Lakes, where the U.S. planned an ambitious invasion of Canada. Although the invasion failed, the U.S. was eventually able to control the lakes by launching a formidable fleet against a poorly-supplied British command. On the Atlantic side, American privateers scored a number of victories at the beginning of the war, but the British stifled these attacks by blockading the most active U.S. ports to prevent the fast ships from getting to sea. A flotilla system was instituted to provide safety in numbers. With only a few frigates and nothing to match the large British ships, the U.S. Navy was unable to break the blockade. With trade being strangled, the public began to demand a more effective naval force. Congress finally acted in 1813, authorizing three 44-gun frigates and six 18-gun sloops-of-war. Later appropriations followed, but many of the ships constructed were launched too late to be effective in the war. By 1814, the British were able to attack coastal cities, striking a

demoralizing blow on Washington, D.C., in August 1814 (Cassavoy and Crisman 1988:171–173, 178, 188; Chapelle 1949:255).

Despite the advantage held by the British, and with the U.S. on the verge of bankruptcy and anti-war sentiment running high, the British signed the Treaty of Ghent in 1814, ending the war. Prime Minister Liverpool saw little to be gained from prolonging the conflict, which had thus far been a stalemate, and from which both countries were suffering from a lack of trade.

Although the War of 1812 was largely a naval war, the majority of the engagements took place on the Great Lakes and in inland waters, particularly Chesapeake Bay. Only a few shipwrecks associated with the conflict are located on the Atlantic OCS. USS *Wasp*, a sloop-of-war constructed at Newburyport, Massachusetts, by Cross & Merrill, is reported (IRSS) to have been lost off the coast of South Carolina, but no reliable location information is known.

12.3.3. The Transatlantic Trade

Many of the issues that had brought on the War of 1812 were not settled by the Treaty of Ghent, but the war boosted American shipbuilding and instilled confidence in commercial interests that the U.S. was capable of defending its maritime rights. The period from the end of the War of 1812 to 1880 was consequently one of rapid growth in the U.S. shipping industry and is often considered the —GoldenAge” of American maritime trade. The period also coincided with the peak development of the sailing vessel, epitomized by the clipper ships, as shipbuilders fought the futile battle to maintain sails in the age of steam (SAI 1981:III-3).

In the years immediately following the War of 1812, New York City emerged as the pre-eminent port of the U.S. Strategically located midway on the coast with a good harbor and quick access to the open ocean, her position was further enhanced by the completion of the Erie Canal in 1825, providing access to the burgeoning Great Lakes and Ohio Valley regions (Laing 1961:183). Great Britain and the U.S. quickly reinstated trade between the two countries after the war to the benefit of both. American vessels could soon be found in ports all over the world. The extent of this trade is evident from shipping trade papers published at New York that documented the arrival and departure of cargo and passenger ships, as well as current market prices for a variety of goods. The *New York Shipping and Commercial List* began publication in 1815 and included information on ships lost at sea, foundered, or run aground, as well as accidents aboard ships (Mystic Seaport 1999). Although location information was generally vague, these reports of —disasters, etc.” provide one of the best sources for documenting American shipping losses for the antebellum period.

Transoceanic trade during the antebellum period was carried out primarily by three-masted, square-rigged ships of 350 tons or more known as packet ships. They were among the most well-constructed sailing vessels to ever be built, with full bows and decks for both passengers and cargo. Packets had their origin in mail ships and passenger vessels of the 18th century. Thomas Jefferson had suggested in 1785 that a regular packet service be instituted between the U.S. and France, with ships scheduled for regular departures and arrivals, an indication of the increasing reliability of ocean travel. However, it was the resumption of trade with England after the War of 1812 that led to the establishment of packet service between New York and Liverpool. The Black Ball Line was the earliest and one of the most successful of the many packet lines

established during this period. Beginning with four ships, it eventually expanded to 39 vessels by 1855. The ships increased in size to exceed 1,000 tons. The Black Ball Line operated until 1878, while its two major competitors, the Red Star and Blue Swallowtail lines, both ceased operations in 1867 (Johnston 1988:235; Laing 1961:221–225).

The packets operated as common carriers and could charge higher rates because of their speed and dependability. By carrying mail, perishable goods, and passengers, they could offset the losses caused by sailing without full cargo holds. The New York to Liverpool packet service was so successful that service to France was instituted in the 1820s, and similar lines were established in other U.S. ports, including Boston, Philadelphia, Baltimore, Charleston and Savannah. Coastal packets called at cotton ports in the South, carrying the fiber to textile mills in England, then returning to New York with manufactured goods. By the 1830s, four packet lines employing nearly 100 ships were operating at New Orleans (Butler 1997:35–38; Laing 1961:226–227).

The success of the transatlantic packet lines put a new emphasis on speed and gave rise to a new era of ship design. Baltimore shipbuilders were noted for their fast privateers, which became the model for the famed clipper ships that emerged in the mid-19th century. *Ann McKim*, built by the Baltimore yard of Kennard & Williamson in 1833, is widely regarded as the first American clipper ship. These tall, square-rigged ships were designed with raked masts, wedge-shaped bows and sweeping sterns that sacrificed storage space for clean, fast lines. The ships generated excitement with the public, which followed their exploits with the intensity of sports fans. The California Gold Rush of 1849 raised the stakes in the sailing ship speed wars. In one year, 800 ships entered the port of San Francisco carrying 90,000 men seeking their fortunes. Most arrived by clippers plying the Cape Horn route around South America, although Cornelius Vanderbilt had success with a combination land and sea route that crossed from Atlantic to Pacific via a 12-mile macadam road through Nicaragua (Butler 1997:65).

In 1850, Samuel Pook, only 23 years old, designed the first clipper built at Boston, the 1,261-ton *Surprise*, which bested the previous record to San Francisco by one day on its maiden voyage. Donald McKay, the industrious Baltimore ship builder, laid out plans for his first clipper, *Stag Hound*, in October of 1850 and launched it just 60 days later. He went on to design and build many of the fastest sailing ships of the day, each progressively larger in size, culminating in *Great Republic* in 1856, a 4,455-ton vessel that carried an acre-and-a-half of sail cloth and a 210-foot main mast. Unfortunately, the vessel burned in a dock fire in New York after sailing from Boston to New York to load its first cargo and was sold and rebuilt on a smaller scale. McKay scaled back his ships when it became clear the demand for such vehicles was not enough to justify the costs of their maintenance and operation (Butler 1997:73–75).

12.3.4. The American Schooner

In addition to overseas trade, coastal trade prospered as Yankee shipyards turned out hundreds of top-sail schooners that could carry a sizeable load with a small crew and were capable of travel on the open ocean. These ships were fore-and-aft rigged vessels with square-rigged sails atop one or both of its masts. The Dutch developed the schooner rig in the 17th century, and this was further refined in America during the 18th century. In the 19th century, the two-masted design was often expanded to three. In the quest for greater capacity, by the end of

the century shipbuilders were experimenting with four, five, and six masts, all of equal size and rigging that required only a modest increase in crew size. These multi-mast vessels benefitted from the development of the steam donkey to assist in hauling lines. However, they proved to be difficult to handle and were often saddled with inexperienced crews to reduce costs. As a result, many met their demise along the Atlantic seaboard. The fleet of schooners amassed by William F. Palmer in the early 20th century serves as an example; of 15 ships, 13 were wrecked, burned or abandoned at sea, and one was torpedoed during World War I. Only one was retired intact. *Thomas W. Lawson*, launched in 1902 with seven masts, was the final desperate effort to extend the schooner principle to a vessel of a size that could compete with the tankers then being built, but it proved unwieldy and sank in a storm off the coast of England in 1907 (Johnston 1988:249; Laing 1961:203–206).

The dependable American schooner could be found all along the eastern seaboard during the 19th century, hauling cotton from Savannah northward, lumber from Maine southward, and all manner of raw materials and finished goods in between. Massachusetts began shipping ice to New York and the Caribbean; lime and granite from Maine were used for concrete and street paving in New York City; turpentine and naval stores from Georgia were major exports to shipbuilding centers in the north; and textiles and leather goods from New England were needed to clothe the growing slave population in the Deep South (Bauer 1988:273–275).

12.3.5. The Slave Trade in the United States

Shipyards in New England benefitted from the ongoing slave trade, despite the region's political opposition to slavery. Many of the states had made the importation of slaves illegal by 1790. However, American ships were frequently used, and many New Englanders were complicit in the trade, which continued to find markets in the Caribbean and Central and South America (Harper 2003). From 1796 to 1807, 44 slave ships entered Havana, of which 35 were American registered, though some were owned by Britons. Representative John Brown of Rhode Island spoke out against a federal law in 1800 that would make it illegal for a U.S. citizen to hold a stake in a slave ship, noting that New England rum, much of it made in Providence, was in great demand in Africa. Although no slaves were imported to Rhode Island, both its shipbuilding and rum industries were inextricably tied to the slave trade. From 1803, when South Carolina lifted its temporary ban on the importation of slaves, until 1807, when the trade was prohibited by federal law, 88 ships from Rhode Island landed 8,000 slaves at Charleston. In 1804, the abolitionist collector of customs at Bristol, Rhode Island, was replaced by Charles Collins, whose brother-in-law, James de Wolf, was a noted slave trader, bringing an end to any prosecutions of slave traders there (Thomas 1997:543, 545).

The slave trade (although not slavery) was banned by both Great Britain and the U.S. in 1807; however, American interests continued to be involved in the business and a coastwise trade in slaves remained active through the Civil War. Rhode Island and Baltimore were major suppliers of ships and captains, while Charleston was headquarters for well-heeled aristocrats who arranged for clandestine deliveries along the coast of Georgia and South Carolina. It is estimated that approximately 50,000 slaves were introduced to the U.S. between 1807 and the start of the Civil War, primarily before 1840. Most of these slaves were smuggled into the southern states through the Gulf coasts of what are now Texas (Spanish until 1821, part of Mexico until 1835, and independent until 1846), Louisiana, and Florida (Spanish until 1818). On

the Atlantic coast, however, Amelia Island, Florida, St. Mary's, Georgia, and any number of barrier islands and isolated estuaries of the Sea Islands of Georgia and South Carolina provided protection for slave traders (Thomas 1997:568–570, 614–617).

The Department of Treasury, through the Customs service, was charged with enforcing the ban, but had no real police force. The scandal of Amelia Island, a well-known slave-trading haven, prompted President Monroe to introduce a more comprehensive Antislaving Act in 1818, and assigned enforcement to a fleet of naval vessels that were dispatched to the coast of Africa. In all, 11 ships were captured with nearly 600 slaves on board. Still, considering the contemporary estimate of one captain that there were 300 vessels of all nations engaged in the trade, the effort had little impact. The U.S. was steadfast in its opposition to British naval ships stopping U.S. flagged ships, and as a result, many slaving ships owned and registered elsewhere began flying the American flag. In 1839, British naval ships brought five slavers flying American flags into New York. Two were Spanish-owned, but the other three were owned by Baltimore merchants and the ships were confiscated. Although American merchants were less involved in the actual trade in the 1840s and 1850s, they continued to turn out ships that were destined for the Brazilian slave trade. In addition to lax enforcement of the slave trade law, there was no prohibition on the trade in slaves between states, and the entrepreneurial-minded carried out a profitable business transporting slaves from the depleted tobacco fields of Virginia to the burgeoning cotton plantations of the Mississippi Valley and Texas (Thomas 1997:615–616, 660–661, 677–680).

12.3.6. The Rise of Steam

While ocean-going sailing ships were reaching their design peak, steam-powered vessels were making their mark on America's waterways. The earliest steam-powered vessels operated on rivers, lakes and other inland waterways. Robert Fulton's sidewheel steamer *North River Steamboat* began service between New York City and Albany, New York in 1807, and was the first commercially successful steamboat operation. After the War of 1812, sidewheel steamers began to make regular runs on navigable rivers throughout the country, most famously on the Ohio and Mississippi rivers between Pittsburgh and New Orleans.

Paddlewheel boats were not ideally suited for ocean travel, however. Ocean crosswinds lifted windward paddles out of the water while submerging the leeward paddles. As the large quantities of coal required for long voyages was used up during the trip, the vessels floated higher in the water, decreasing the paddles' effectiveness. Also, the engine and fuel meant less room for cargo. Sailing ships, meanwhile, were capable of nearly continuous travel, as long as food and water for the crew could be maintained (Butler 1997:24–28). Despite these drawbacks, the promise of regular service offered by the steamship ensured its continued development and use for ocean voyages (Haws 1976:119). In 1838, two paddlewheel steamers, *Sirius* and *Great Western*, arrived in New York within hours of each other, becoming the first vessels to cross the Atlantic using only steam power (Haws 1976:119, 127–128).

Early steamers of the 19th century were generally hybrid ships equipped with sailing rigs that often provided the majority of the power. SS *Savannah*, the first steam-powered vessel to cross the Atlantic in 1819, was in fact a full-rigged sailing ship equipped with a 90-h.p. single cylinder steam engine and collapsible paddlewheels that were stored on deck when not in use. Steam

power was used for only about 80 hours of the nearly 28-day voyage. Gradually, as improvements in design and performance were made to the engines, the sails became the backup power, and eventually were abandoned altogether. They remained a fixture on these ships into the 20th century, however. Tugs and other coastal steam-powered vessels were generally not equipped with sails.

Steamships began to ply the Atlantic seaboard in the 1820s, beginning with service between New York and various New England ports through Long Island Sound. In 1824, Captain Seward Porter of Portland, Maine, announced plans to operate the 300-ton steamship *Patent*, —elegantly appointed for passengers,” between Portland and Boston (Preble 1883:114), although regular service was not established until the 1830s (Bauer 1988:108). A number of lines operating out of New York were incorporated by J.P. Morgan into the New England Steamship Company, which became famous as the carrier of New York’s industrial and financial elite between the city and their summer homes in Rhode Island. In 1846, Richard Borden opened a railroad between Boston and Fall River, Massachusetts, where he operated steamships to Providence. In 1847, he began regular service to New York. Passenger steamers were soon operating between New York, Baltimore, Norfolk, Charleston, and Savannah.

The construction of steamboats required considerable use of iron, which eventually found its way into the frames, fittings, and hulls of sailing vessels as well. As quality timber became scarcer, the importance of iron increased. The need for iron foundries and iron workers around shipyards gave an advantage to Northern yards, where capital and labor were more plentiful. The more complex designs and need for expensive mechanical tools favored larger facilities over smaller traditional ones, and shipbuilding declined in places like Salem and Bangor, as well-financed yards in Boston, Philadelphia, Baltimore, and Hampton Roads came to dominate the industry (Butler 1997:37–38).

Iron provided the material necessary for another development in steamboat technology, the use of screw propulsion. Initially, steam engines were not able to produce sufficient power to drive a large ship with a propeller, but the addition of second and third cylinders to the engines and the use of hot burning anthracite coal increased horsepower and made screw propulsion more practical. Swedish engineer John Ericsson introduced a number of improvements to propeller-driven vessels and is credited with the first American commercial steamship with screw propulsion, *Robert F. Stockton*, in 1839. His USS *Princeton* was the first steam-powered warship, and he was instrumental in designing USS *Monitor* in the Civil War (Butler 1997:40). In 1845, HMS *Rattler* proved the superiority of screw propulsion in a tug-of-war with an identical ship fitted with paddles. Still, paddlewheel steamships continued to be built, in part because of mail contracts requiring their use (Haws 1976:133–134).

Perhaps of more concern for the paying passenger than the mode of propulsion was the care and operation of the boilers. Early steam vessels were exceedingly dangerous. The steam engines were notoriously temperamental and required constant attention. Corroded pipes, inattentive operators, dirty stacks, and faulty valves often led to disastrous explosions and fires. Scalding steam, consuming flames, and rapid sinking cost thousands of lives. Maginnis (1892) reported more than 6,300 lives lost on passenger steamers of the Atlantic between 1840 and 1892. The dangers of steamship travel prompted Congress in 1838 to pass a steamboat safety law that required inspection of passenger vessels powered in whole or in part by steam. This piece of

legislation was one of the first to regulate private industry for the benefit of the American public (Voulgaris 2009). The law was administered by the Justice Department, but did not provide for an enforcement agency. Between 1847 and 1852, a series of disastrous boiler accidents, fires, and collisions highlighted the need for codified regulations and stricter enforcement. In 1852, Congress passed the Steamboat Act, which placed the enforcement under the Treasury Department and created nine districts with inspectors assigned to each. The regulations did not apply to non-passenger vessels, however, and crews were continually at risk from poorly-maintained machinery. In 1871, the regulations were extended to all steam-powered vessels, and a comprehensive Marine Safety Code was established. The 1871 Act also provided for the creation of the Steamboat Inspection Service as a formal entity (Voulgaris 2009).

At about the same time that the first steamboat act was passed, it had come to the attention of Congress that the nation's lighthouses were inadequate. Administration of these —aidsto navigation” had been carried out with a lack of oversight by a number of governmental departments with little maritime expertise. Lights were poorly placed, poorly maintained, and lacking improved equipment that would make them more effective. After more than a decade of investigations, reports, and recommendations, Congress overhauled the Lighthouse Service beginning in 1852. Twelve districts were created with an inspector for each. Operators were required to be licensed and to submit frequent reports that were published as —Notes to Mariners” (Butler 1997:50–51, 75–76).

In 1838, the British ship *Great Western*, a wooden, paddlewheel steamer, crossed the Atlantic in 15 days, launching a new era of transatlantic travel using steam-powered vessels. The ship's owners, the Great Western Steam Ship Company, established the first regular transatlantic service by steamship between England and New York. Great Western Company foundered, however, when it lost out to Samuel Cunard for the British mail contract. Cunard was able to put four paddlewheel steamers into service between Liverpool and Boston starting in 1840, while the Great Western Company had only one vessel. In 1845, after extensive delays, Great Western Company launched the massive *Great Britain*, the first iron-hulled, screw-driven steamer, which was by far the largest vessel then afloat. *Great Britain* was plagued with troubles, however, and eventually bankrupted the company when it ran aground in 1846. Another British line running the New York route, the British and American Steam Navigation Company, also was bankrupted by the loss of one of its two ships, *President*, in 1841 (Corlett 1975; Gibbs 1963).

Great Britain represented the future of transatlantic travel, but further developments in design and construction would be necessary before such ships were profitable. Meanwhile, the Cunard line was highly successful by stressing safety and using ships that were similar in design to SS *Great Western*. In 1848, the Cunard line received a subsidy from the British government to increase the frequency of its departures in order to compete with new lines launched by American competitors. The mail packet's terminus was switched to New York at that time.

Concerned about the Cunard monopoly, in 1845 Congress authorized subsidies to American shipping lines that could carry the mail in ships capable of military service in case of war. Several routes were established under this authorization, including service to France, Central America, and the Pacific Coast. It was not until 1847 that Edward Collins proposed a line to compete with Cunard, launching the United States Mail Steamship Company in 1850 with four ships departing bi-weekly from Liverpool and New York. At nearly 3,000 tons, the Collins

Line's ships were twice as large as Cunard's vessels, and *Atlantic* established a new record for the west-to-east crossing on its maiden voyage. Unfortunately, two other ships in the line were lost to accidents with significant loss of life, eventually leading to the demise of the company (Johnston 1988:241–242).

12.3.7. The Civil War at Sea

The effectiveness and dependability of steamships would be tested in the crucible of war. The U.S. Civil War would mark the first significant use of steamships in naval warfare, along with a number of other maritime technological developments, such as iron hulls, submarines, and shell artillery (Watts 1988:207).

A naval blockade of the Confederate States was a crucial part of the U.S. strategy, but the Navy was in poor condition. Of the 90 ships in the fleet at the beginning of the war, only 41 were in active service. Many of the officers were Southerners who joined the Confederacy. However, the Union had the resources to build up the navy, with most of the major shipyards and industrial facilities located in the Northern states. The Northern ports were also home to the vast merchant marine fleet that had been engaged in commercial trade, but was now called upon to contribute to the cause. Secretary of the Navy Gideon Welles oversaw the naval buildup, purchasing existing vessels and outfitting them for service, refurbishing existing vessels, and ordering the construction of new ones. Among the hundreds of ships armored for blockade duty were many paddlewheel and screw-driven steamers (Preston and Natkiel 1986:117–118).

The Confederate naval vessels were superior to this patchwork fleet, but the Union had a significant numerical advantage. Although Confederate warships scored some significant naval victories against the Union blockade, with its superior numbers the Union was able to effectively impact the export of cotton to England and the import of food and other vital supplies to the South. The Confederacy had more success with its privateers and commerce raiders, which disrupted Northern commerce by capturing commercial vessels on the high seas and keeping Union warships preoccupied with protecting its merchant fleet. The steamer CSS *Alabama* captured or destroyed 76 vessels from the North Atlantic to the Indian Ocean.

In an effort to break the blockade, the Confederate Navy constructed a fleet of ironclad gunships, but the Union was able to draw on its foundries and shipyards to counter the effort with its own fleet of armored ships. The Confederates' first ironclad was *Merrimack*, a U.S. frigate salvaged after the capture of the Norfolk Navy Yard. The Union was aware of the conversion of *Merrimack*, and called on Swedish engineer John Ericsson to develop a similar gunboat for the federal navy. Ericsson responded with USS *Monitor*, a superior vessel that was more maneuverable and was equipped with a revolving gun turret. *Merrimack*, rechristened CSS *Virginia* had already dispatched with two Union blockade vessels when *Monitor* appeared on the scene at the mouth of Chesapeake Bay. Neither ship was able to penetrate the armor of the other, and the two vessels withdrew in stalemate. The ships engaged each other cautiously over the next two months, with each captain reluctant to risk the loss of his ship. *Virginia* was scuttled in the Elizabeth River, Virginia, in May 1862 when it was unable to escape the Union invasion of the Peninsula. *Monitor* was lost in a squall off of Cape Hatteras on New Year's Eve, 1862. Her location was unknown until 1973, when magnetometer and side scan sonar identified the remains in 230 feet of water. Artifacts and large portions of the ship, including the propeller and gun

turret have been recovered from the ship over the last four decades (Preston and Natkiel 1986:119–120; Watts 1988:210–211).

The engagements between *Virginia* and *Monitor* demonstrated to both the Union and Confederacy that the ironclads were indispensable components of an effective naval force. Approximately 25 armored warships were put into service by the South and served effectively in river and harbor defense. John Ericsson continued to develop ironclad ships for the Union navy, and contracts were let for other classes of “monitors,” as they became known, from other designers, as well. Twenty-seven such vessels saw service for the U.S. Navy in the Civil War. Three Union monitors—*Weehawken*, *Keokuk*, and *Patapsco*—were lost off Charleston, South Carolina. In addition to these full-sized armored vessels, many armored gunboats were produced by both sides for river and harbor defense. These were steam vessels of approximately 100-foot length, outfitted with one or two guns. Because they were not intended for extended travel in the open ocean, few of these are known to have wrecked in the federal waters of the OCS. However, CSS/US *Atlanta*, which was sold to Haiti after the war and renamed *Twilight*, later sank off Cape Hatteras and has not been found (Watts 1988:214–217).

While ironclad gunships battled each other for control of the U.S. coast, another class of vessel, the blockade runner, was being developed to try to slip through the Union patrols and deliver needed goods to the Confederacy. All manner of vessels were involved in running the blockade, but the most successful examples were sleek, shallow-draft, steam-powered vessels designed for speed. British merchants transported goods to neutral ports in the Caribbean and Bermuda, then loaded the cargo on these smaller, faster vessels. As the Union blockade tightened around Charleston and Savannah, the favored port for these runs became Wilmington, North Carolina. At the outset of the war, blockade-running steamers were ships originally designed for river service, but as these were captured or lost, they were replaced by vessels specifically designed for blockade running, many of them built in England. *Banshee*, built in Mersey for this purpose, was a light, steel-hulled ship, the first of its type to cross the Atlantic. The iron-hulled *Flora* had telescoping masts and stacks that could be lowered to make the vessel less visible. Sailing on moonless nights and in bad weather to avoid capture, as many as 30 steam-powered blockade runners were lost around the entrance to the Cape Fear River alone (Watts 1988:216–219).

Yet another innovative vessel put to use during the Civil War was the submarine. Submersible vessels had been developed by a number of scientists and engineers during the 19th century, but considerable improvements were necessary to make them useful for military purposes. French engineer Brutus de Villeroi accepted a contract with the U.S. Navy to construct a submarine for service in Hampton Roads. De Villeroi’s design, which used duck foot-like paddles, proved impractical. Meanwhile, Confederate financiers, led by Horace L. Hunley, sponsored the construction of three different submarines, the last of which, named for its chief patron, became the first submarine to sink an enemy ship when it planted an explosive device in the hull of USS *Housatonic* in Charleston Harbor, before itself sinking (Watts 1988:225–230). The remains of *H.L. Hunley* were positively identified in 1995, and the vessel, with its doomed crew of eight still inside, was recovered with much fanfare in 2000. Although submarines had no significant impact on the outcome of the war, the stage was set for their future development, and they would play a major role in World War I.

12.4. DECLINE OF U.S. MERCHANT SHIPPING

The Civil War had a significant effect on American shipping. Over 100,000 tons of shipping capacity had been lost to Confederate commerce raiders and other causes during the war, and nearly 800,000 tons had been removed from American registry to avoid the same fate. In addition, the vast forests of the Eastern Seaboard were nearly depleted of the timber needed for large wooden vessels. Iron and steel were replacing wood, and England was leading the way in the transition. Shipyards in New York and Boston had given up on wooden ships by 1870. Startup costs were high for converting to metal hulls, and much of the available raw material and capital was controlled by the railroads. American labor costs were high, as well. As a result, American-built ships were considerably more expensive than their British counterparts. Although large, ocean-going ships were no longer built in American yards, a variety of smaller vessels such as coastal schooners, fishing boats, work boats, and recreational craft were turned out by American builders (Bauer 1988:241–243, 289).

During the late 19th and early 20th centuries, U.S. merchant ships concentrated on specialized trade routes with Central and South America and the Caribbean, while maintaining a steady coastal trade in iron ore, coal, and other commodities. U.S. shipping lines built their fortunes on coffee from Brazil, guano from Chile and Peru, and bananas and other tropical fruits from the Caribbean basin. These trade routes provided service for aging sailing vessels that were being eclipsed by steam packets in the trade in manufactured goods (Bauer 1988:244–246).

Many sailing vessels were also pressed into service as barges towed by steamships and tugs along the Atlantic seaboard after the Civil War. Railroads were carrying much of the cotton that had once been transported by water from the South, and cargo ships increasingly carried bulk materials for which speed of delivery was not critical. This included coal, lumber, sand, stone, and lime. By 1907, these products accounted for about 65 percent of the Gulf and Atlantic coastal trade. All of the coastal trade was less than 10 percent of the tonnage carried by the railroads. Manufactured goods were still regularly shipped from New England factories to New York merchant houses by sea, however. Shoes, clothing, and paper were generally handled by New York concerns, which shipped the products by railroad to the rest of the nation. Cargo ships were able to transport these goods to New York as quickly, and more cheaply, than the railroads (Bauer 1988:261–262).

Of the coastal trade products, coal was the most vital, having become the most common fuel for steamships, railroad locomotives, heating, manufacturing, and electricity. Much of the coal for the Eastern Seaboard came from West Virginia and was shipped by railroad to Newport News and Norfolk, Virginia, and loaded on to schooners and barges. Multi-masted schooners remained the most common type of vessel to haul coal long after steamships had supplanted sail for most commercial shipping. These ships could be built with a large capacity, yet operated by a small crew. In 1880, Goss, Sawyer, and Packard in Bath, Maine, launched the four-masted *William L. White* that was nearly 1,000 tons. It was so popular that the company built 67 more over the next 10 years. Beginning in 1889, they turned out 55 five-masted schooners that were even larger still. By the early 20th century, however, these vessels had reached their maximum practical size, while steel-hulled steam- and gas-powered vessels were nearly boundless in capacity and were becoming cheaper to operate (Bauer 1988:270–273).

The importance of the coastal trade is reflected in the attention given to safety and navigation during the late 19th century. The large number of wrecks along the Atlantic coast prompted the Treasury Department to overhaul the life-saving stations that had been funded by the U.S. Revenue Marine since 1848, but which had suffered from neglect and mismanagement. Preventing the loss of lives and property at sea was seen as beneficial to commerce by reducing insurance rates and encouraging shipping. In 1871, Sumner Kimball, the newly appointed chief of the Revenue Marine Division of the Treasury Department, ordered a complete inspection of the life-saving stations, and subsequently secured funding for updating equipment, mandated adequate training and pay for recruits and superintendents, and ordered more extensive record keeping (Noble 1988:5–10). The result was not only an increase in the number of ships and crews saved from total disaster, but a thorough record of accidents along the Atlantic Seaboard.

A number of American steamship lines continued to provide transatlantic service in the late 19th century, despite the obstacles cited above. Many of these lines relied on the less lucrative immigrant market, while maintaining mail service contracts with the federal government to supplement receipts. The Red Star Line was the most successful of these, which operated under the Belgian flag. Another American-owned line that operated under a foreign flag was the Guion Line, which used British-built and flagged vessels for the Liverpool to New York route. The company moved toward luxury liners in the late 1870s, but struggled to operate profitably and went out of business in 1894. American financier J.P. Morgan organized a number of these American-owned lines, as well as several major foreign-owned ones into the International Mercantile Marine, which attempted to challenge the Cunard Line's dominance of the transatlantic trade. The company overestimated the value of some of the acquisitions, however, and the loss of the White Star Line's *Titanic* in 1912 pushed the company into receivership (Bauer 1988:246–249).

Coastal steamship lines offered passenger service along the Atlantic Seaboard well into the 20th century, although railroad travel was gradually becoming more convenient for such trips. The Chesapeake Bay relied on maritime traffic for longer than other regions because of the difficulties of building railroads over the many bodies of water. The Baltimore Steam Packet Company, better known as the Old Bay Line, was the principal player in that market, and maintained its dominance by switching to iron hulls soon after the Civil War. New Orleans, Houston, and Galveston were key ports on the long-distance coastal routes. Charles Morgan's Louisiana and Texas Railroad and Steamship Company was the major player in Houston, and was later absorbed by Southern Pacific (Bauer 1988:267–269).

In 1888, the first American-built oil tanker, *Standard*, was produced by American steel ship pioneer John Roach for John D. Rockefeller's Standard Oil Company. Standard Oil gradually built up a fleet of 60 tankers to transport its crude oil to coastal refineries. The Shell Transport and Trading Company, with 15 ships, was its only real competitor. However, the breakup of the Standard Oil monopoly in 1911, coupled with the development of the internal combustion engine and its widespread use during World War I, created an explosion in the demand for tankers, and over 300 were built between 1916 and 1921 by the U.S. (Devanney 2006:14–18).

Internal combustion engines also began to be used to power other boats and ships, particularly smaller vessels, in the early 20th century. This freed the owners from federal steamboat regulations, which required a licensed engineer to operate the engine, a considerable

expense for modest commercial vessels. Diesel engines were in use in submarines and other applications during World War I and began to appear in civilian vessels soon after. By the start of World War II, diesel had largely replaced steam for large vessels then under construction. Steam continued to be used in turbine engines that powered electrical motors, however. Turbo-electric drives developed by Westinghouse were used in U.S. battleships and aircraft carriers. The turbo-electrics became less popular after the gearing problems that had previously plagued turbine engines were solved (Bauer 1988:291–293).

The shipbuilding industry revived in the last decade of the 19th century as the Navy built up its steel-hulled “White Fleet,” and commercial shippers began to replace outmoded vessels that could no longer be made useful. The Newport News Shipbuilding and Dry Dock Company, a subsidiary of the Chesapeake and Ohio Railroad, became one of the largest and most efficient shipyards in the U.S. It continues today as a part of Northrup Grumman and builds nuclear submarines and super carriers (Bauer 1988:293–296).

The U.S. merchant fleet at the turn of the 20th century was woefully inadequate for the growing U.S. presence as a world power, despite the growth of the shipbuilding industry in the 1890s. Woodrow Wilson was a strong advocate for the merchant marine and in 1916 Congress approved his proposal for a U.S. Shipping Board. The board created the Emergency Fleet Corporation (EFC) that built up the merchant marine with a fleet of utilitarian, contract-built, wooden- and steel-hulled vessels that proved seaworthy if not glamorous. The goal was to build a “bridge of ships” to France. Attacks on merchant and passenger ships by German submarines had drawn strong rebuke from the U.S., which was finally drawn into World War I in early 1917. Nearly two dozen ships were sunk by German U-boats before the end of the war.

The EFC building program led to the construction of dozens of new shipyards and fabrication plants, although much of the proposed work was not completed before the end of the war. Still, the program introduced the approach of separating the fabrication and assembly facilities to shorten production time, which spread the benefits of the program along the coasts of the entire country. In two short years, the number of “ways” (the racks upon which ships were built) in the nation’s shipyards had increased more than four-fold. By 1922, the U.S. had the largest merchant marine fleet in the world and controlled 22 percent of the available tonnage. Unfortunately, it did not have the shipping industry or trade connections to fill the holds (Bauer 1988:297–301).

The glut of ships brought shipbuilding to a halt and left the federal government with hundreds of vessels that it could not afford to operate. An effort to sell or lease these ships and their routes to private enterprise met with little success. The EFC fleet also delayed the use of diesel engines in large craft, since the vessels were built before improvements were made in the engines during the war. Diesels were quickly adopted by work boats, fishing vessels, and recreational boats, however. Government subsidies for overseas mail service spurred some companies to start or revive shipping lines, and funds from the Shipping Board for new construction resulted in modest production of coastal vessels to replace aging fleets. The value of the board was further brought into doubt by cases of corruption that emerged in the 1930s regarding these federal subsidies and contracts (Bauer 1988:302–306).

With the rise of fascism in Europe, President Franklin Roosevelt suspected that the U.S. would be drawn into war and was convinced of the need for a strong merchant marine fleet. He

overhauled the Shipping Board with the creation of the U.S. Maritime Commission. The Commission proposed the construction of 500 vessels by 1947 under its Long Range Shipbuilding Program. By 1940, about 150 well-designed and versatile cargo ships had been built, which served well as transport ships during World War II. However, the heavy losses incurred by the British at the hands of the German U-boats showed that a more urgent effort was required, and in 1940 the Long Range program was scrapped for the Emergency Shipbuilding Program. The emergency building program produced over 2,600 —Liberty Ships,” the hastily-built, but serviceable cargo steamers that were not intended for post-war service. In addition, 534 —Victory Ships,” an improved version of the Liberty Ships, were completed as well. A large number of these were sold after the war to foreign countries, helping to re-establish a worldwide shipping industry (Bauer 1988:306–311; Butler 1997).

12.4.1. Losses in U.S. Waters in World War II

War activities resulted in a large number of shipwrecks in the Atlantic OCS area, not only from German submarine activity, but from training exercises and accidents involving all manner of vessels and aircraft.

The U.S. staunchly maintained its neutrality through the 1930s, but with the fall of France and Italy’s entry into the conflict on the side of the Axis powers in 1940, Britain’s ability to control the seas and supply its Allied forces was seriously imperiled. The U.S. came to the Allies’ aid with the transfer of 50 U.S. World War I destroyers to Great Britain in September 1940 and the passage of the Lend-Lease Act in March 1941 that provided for a steady supply of materiel in exchange for various in-kind payments. Roosevelt’s promise to provide all aid short of war provoked Germany to ramp up its submarine warfare effort against U.S. shipping. In May, a German U-boat sank an American merchant ship carrying no military supplies off the west coast of Africa, making it clear that U.S. shipping would require military support to remain unmolested at sea. In early 1942, Germany launched Operation Drumbeat, sending U-boats to the U.S. east coast, refueling them from tanker ships. With no blackouts in effect, the submarines could track ships at night by spotting their silhouettes against the lights of shore. Unarmed, the merchant vessels were sitting ducks. Nearly 400 ships were destroyed and 5,000 seamen killed in a six-month period before the U.S. implemented the necessary changes to curtail the losses and began assigning full convoy protection to its merchant ships. With these protections in place, the Germans shifted their focus back to massed attacks in the North Atlantic against the heavily guarded convoys (Butler 1997:175–177).

One of the first vessels sunk by German submarines off the Atlantic Coast was SS *Norness*, a German-built, Panamanian-flagged oil tanker of approximately 9,600 tons that was torpedoed by *U-123* about 60 miles off Montauk, Long Island. One of the largest vessels taken out by the U-boats was MV *Amerikaland*, a German-built twin-screw diesel cargo ship of over 15,000 tons built in 1925. It was sunk about 75 miles off of False Cape, North Carolina. Another large vessel lost off the coast of North Carolina, *Ulysses*, was a 14,647-ton, steel-hulled British merchant ship that was torpedoed about 45 miles south of Cape Hatteras in April 1942 by *U-160* (uboa.net 2011).

USS *Bass*, lying in 160 feet of water off the coast of Rhode Island, is an example of an intentional shipwreck used for military training. The 2,500-ton SS-164 submarine was used for

target practice 7.5 miles south of Block Island Southeast Light. The ship had earlier burned off the coast of Panama, resulting in the loss of 25 lives (IRSS).

The Battle of the Atlantic continued into 1943, by which time the Allies had developed improved tracking technologies and weapons that were finally successful in blunting the U-boats' attacks. Also of consequence was the sheer number of ships that the Allies were able to bring to the convoys, most of them American-built, which gradually eroded the German effort to isolate Great Britain and force its surrender.

Many of the vessels sunk during Operation Drumbeat, including lost German U-boats, have been identified or recovered by modern salvors and diving enthusiasts. NOAA has conducted search expeditions over the last two years under its Battle of the Atlantic program, an effort conducted in consultation with the British and German governments, with technical expertise and logistical support from various federal agencies, including the BOEM, and numerous colleges and universities. In 2008, the Battle of the Atlantic expedition documented the remains of three German U-boats. In the summer of 2009, the remains of the retrofitted fishing trawler *YP-389*, which was sunk off Cape Hatteras in June 1942, were identified (NOAA 2009).

12.4.2. U.S. Shipping and Maritime Activity since World War II

World War II established the U.S. as a world power and put the U.S. merchant marine back on the world stage. The Marshall Plan, launched in 1948, put billions of dollars worth of cargo into American ships destined for Europe and other areas affected by the war. In that year, there were 3,644 U.S.-flagged ships operating in international trade, the most ever for the country. However, postwar aid also benefited the other shipping powers of the world, and over the next 50 years the U.S. gradually fell into the background.

The U.S. Marine Commission launched a new type of vessel in 1950 to replace the Liberty and Victory ships, which were in need of updating. The Mariner class, a 14,000-ton, steam turbine vessel with updated electronics and rigging, was capable of a remarkable 20 knots, and the ships served well in the Korean War. Two dozen were put into service by three different shipping lines in the first five years and over 50 were eventually built. However, diesel engines were proving more economical if somewhat less powerful than steam. In addition, container ships, with their large undivided cargo holds were replacing the "stick ships," of the early 20th century (Butler 1997:196).

Labor cost, government regulation, and a shift in the U.S. from manufacturing and trade to a service economy resulted in the decline of U.S. owned and operated shipping lines. Vast container ships now fly flags of convenience and carry small international crews, few of whom are American.

Passenger liners, long considered the most fashionable and luxurious way to travel, could not compete with the speed and convenience of airlines. The giant luxury liners *America* and *United States* of the United States Lines no longer provided transatlantic passenger service by the end of the 1960s. However, the U.S. retained a strong presence in the tanker industry, carrying 21 percent of the world's oil in 1954 (Butler 1997:199; Sloan 2004).

The second half of the 20th century saw significant improvements to navigation technology, with the widespread availability of radar, sonar, and Loran positioning systems. The Coast Geodetic Survey and the Hydrographic Office compiled modern charts based on data gathered during the war effort, and the satellite mapping and monitoring beginning in the 1960s made it possible to update data more rapidly (Butler 1997:197).

Increased leisure time and disposable income led to a dramatic increase in the number of recreational vessels, both sail- and motor-powered, in U.S. waters after World War II. Chartered fishing and diving boats also were increasingly common. While increased regulation and technological advancements continued to make commercial vessels safer, recreational and charter vessels were more likely to be involved in accidents as a result of their small size, inadequate safety precautions, poor maintenance, and inexperienced or impaired operators. Coast Guard Disaster Files at the U.S. Coast Guard Headquarters in Washington, D.C., document accidents involving private vessels for which they were involved in the rescue efforts.

12.5. DISCUSSION OF VESSEL TYPES

Mariners are known for their extensive jargon, and identifying vessels and their components is an integral part of the maritime vocabulary. As with any typology, vessels could be categorized in a variety of ways, and naming conventions are notoriously inconsistent (U.S. Bureau of Marine Inspection and Navigation 1886). Sailing vessel types were based on size, hull shape, and rigging, as well as function. With the advent of engine-driven vessels, the type of engine and type of propulsion came to define the type of vessel. Increasingly specialized vessels also contributed to an expansion in the number of vessel types referred to in contemporary nomenclature. The vessel types described below are presented in a roughly chronological manner, with the prominent ocean-going vessels of each period covered.

For the purposes of the current shipwreck database, vessel type is based on that given by the source of information on the wreck, using the codes and types developed by Pearson et al. (2003) for the Gulf of Mexico shipwreck database. Many of the types listed by Pearson et al. were not encountered in the current investigation, and a number of new types were added that could not be easily fit into the existing typology. These include the ship of the line, man of war, pilot boat, scow, and the ship's boat, which includes the long boat, shore boat, and tender.

Although there is considerable variation within types, the characteristics of major vessel types can help to identify wrecks in the field. Descriptions from secondary and contemporary sources are discussed below. They are drawn from Gibbons (2001), László and Woodman (1999), Culver (1992), Kemp (1980), and U.S. Bureau of Marine Inspection and Navigation (1886). Figure 12.1 identifies some of the major components of a sailing vessels' rigging, by which many vessels were categorized.

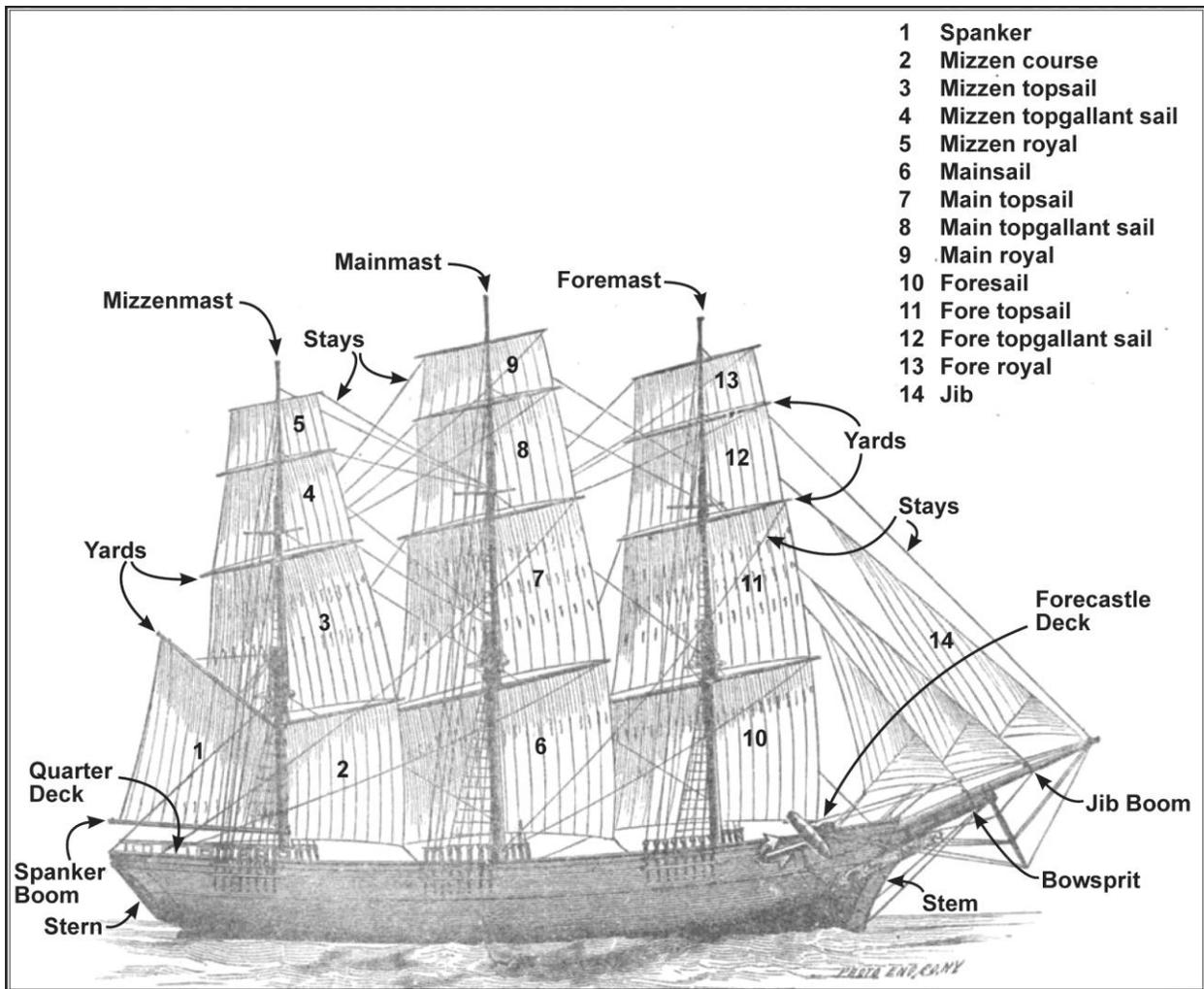


Figure 12.1. Components of a historic sailing vessel (illustration from U.S. Bureau of Marine Inspection and Navigation 1886; terms from Royce 1986).

12.5.1. Sailing Vessels of the Age of Exploration

The earliest European vessels to be found along the Atlantic Seaboard of the United States were the sailing vessels of the Spanish, English, Dutch, and French explorers of the 15th, 16th, and 17th centuries. These vessels developed from a merging of Northern and Southern European traditions during the late Middle Ages to create a sailing ship that was adaptable to long periods at sea and could further the ambitions of European powers seeking to extend their influence. The Mediterranean caravel was built on a frame that allowed for larger hulls than the cogs of Northern Europe, while the square-rigging of the cog proved better suited to the demands of ocean travel than the lateen sails used in the Mediterranean. The resulting vessel was called the *caravela redonda*, which was one of the vessel types used by Columbus and the Portuguese explorers of the 15th century.

Caravel. The fore-and-aft rigged, carvel-built vessels developed by the Spanish and Portuguese in the 15th century were the standard exploration ship. The butted and caulked planks

on a frame provided a stronger longitudinal hull, which could carry greater amounts of cargo and handle the stresses created by the increasingly elaborate sailing rigs being developed. The larger caravels were typically fitted with four masts, and were capable of long days at sea. However, the fore-and-aft rig on the front proved difficult to handle in severe weather and was replaced by square-rigging in the *caravela redonda*. A caravel fitted with armaments was called a *caravela de armada*. The traditional, lateen-sailed caravel was known as the *caravela latina*. Ocean-going caravels were often referred to simply as *naus*, a term for a large merchant vessel, usually with three masts.

Carrack. The carrack was a large merchant ship and warship that carried a rig similar to the *caravela redonda*, that is, a mixture of square sails in the front and lateen sails on the mizzen mast. They typically carried a large mainsail, and were characterized by prominent fore- and aftercastles, which made them cumbersome in a crosswind. With their robust construction and large size, carracks were intimidating war vessels. Guns originally mounted in the castles were eventually moved below decks with the development of the gunport, resulting in a less top-heavy vessel. As the size of the carracks increased, the masts were increased in number and height, and some vessels approached 2,000 tons. In the 17th century, however, the carrack was gradually replaced by the sleeker and more maneuverable galleon. A replica of Columbus's carrack *Santa Maria* is shown in Figure 12.2.



Figure 12.2. A replica of *Santa Maria*, Columbus's flagship (WikiMedia Commons 2006).

Galleon. Originally a larger carrack refined for ocean voyages, the galleon developed into a sleek, versatile craft that was well-suited to the needs of national fleets guarding convoys of trade vessels. The prow was lowered and the large mainsail incorporated into a more balanced sail plan. At the end of the 16th century, English ship designer Sir John Hawkins created the race-built galleon, a version which further improved its speed and maneuverability by eliminating the high forecastle, lowering the aftercastle and sides of the ship, and replacing the round stern with a square one. The galleon was soon adopted by all the European navies and served as the basis of fighting vessels through the end of the age of sail.

12.5.2. Naval Vessels of the Age of Empire

The success of the galleon led to the development of a number of specialized vessels that provided protection to the fleets of the Spanish, Portuguese, French, English, and Dutch as they sought to control the world's trade during the 17th and 18th centuries. Increasingly large gunboats were also constructed to engage the enemy's armadas.

Frigate. This term came to be applied to warships fitted with broadside guns. Frigates were generally single-decked, 3-masted vessels carrying between 28 and 36 guns. They served as scouts, interceptors, and escorts. The hull design was low, emphasizing speed and sea-worthiness in all conditions. The earliest examples were used as merchantmen as well as gunships, but by the middle of the 18th century, the true frigate emerged as a dedicated fighting ship. In the second half of the 18th century, Britain and France built increasingly large frigates for use in their ongoing war of the seas. These 40- to 50-gun vessels proved as effective as double-decked ships with equal numbers of guns. The first six vessels constructed for the U.S. Navy at the end of the 18th century were frigates, with the 44-gun *Constitution* being the most well-known. In the 19th century, what were essentially two-decked frigates were constructed by connecting the forecabin and quarter deck in a continuous line to form the spar deck, where a second row of guns was mounted. The frigate USS *Boston*, constructed in 1799, is shown in Figure 12.3.

Ship of the Line. Multiple-decked vessels with 40 or more guns were called ships of the line, or line-of-battle ships. In the standard battle formation that developed in the 17th century, these ships took up position in a line, engaging the enemy ships in a parallel line as they sailed with the wind. The largest of these ships, such as the British *Soveriegn of the Seas* built in 1637, were 3-decked, 100-gun vessels. Eventually, 120- and 140-gun ships were built, but these were rare because of the cost and restrictions on size imposed by wooden construction.

Man-of-War. This term was applied to any number of armed sailing vessels, generally large war ships, although of no defined size.

East Indiaman. These Dutch ships of the colonial era were primarily trading vessels outfitted with guns to fight off pirates and privateers. They were deep-draught, 3-masted, square-rigged vessels of 500 to 1,200 tons. Their large capacity made them slow, but they were well-armed and presented a low profile to an attacking vessel. The vessels were well-appointed and often richly decorated, and were the pride of the Low Country. The **flute** was a smaller, 3-masted Dutch vessel of the 16th and 17th century that was confined primarily to European waters.

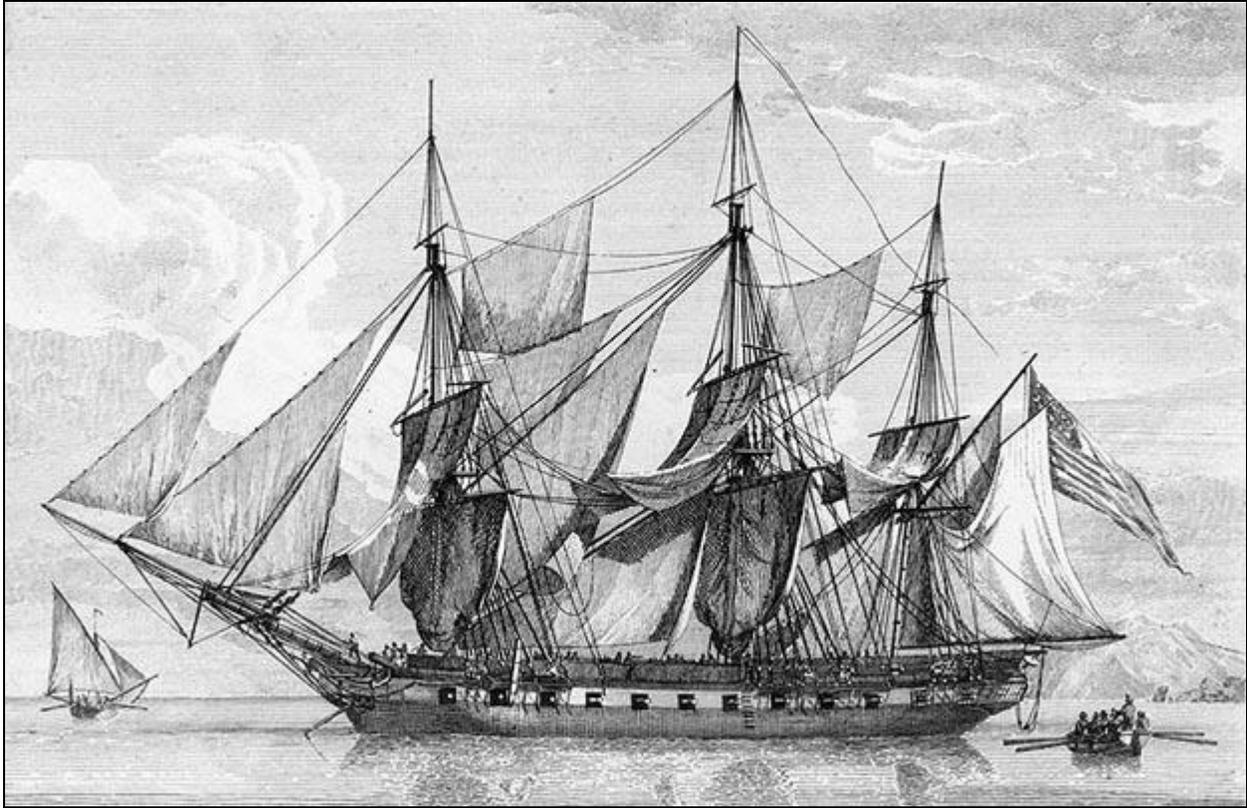


Figure 12.3. The frigate USS *Boston* in the Mediterranean in 1802 (U.S. Naval History and Heritage Command n.d.).

12.5.3. Coastal vessels

Cutter. Like the frigate, the term *cutter* was applied to a large number of small, fast vessels used as patrol boats, escorts, and privateers. The sailing cutter typically had one mast with a gaff-rigged mainsail and a number of foresails set on a long bowsprit. The gaff-rigged sail is a four-sided, fore-and-aft sail that is attached to the mast by one edge rather than in the middle like a square sail. Cutters sometimes carried square topsails, as well. They were distinguished as much by their sharp lines as their rig. Their speed and ease of handling made them popular with smugglers as well as revenue officers. They were also employed as pilot boats using a simpler rig.

In modern usage, the Customs Service and the Coast Guard continue to refer to all of its patrol boats, including motor vessels, as cutters. The term cutter is also used for a type of yacht with a Bermuda-rig (triangular mainsail) or gaff-rig.

Lugger. Originally used as a coastal fishing vessel, the lugger is a small ship with one or more masts rigged with lug sails. Lug sails are a type of fore-and-aft rigged sail that have four sides and are secured to a yard that is attached to the mast off-center, allowing one side of the sail to be higher than the other. With lugger topsails added, the vessel could carry a vast amount of sail. The French lugger, or *chasse-marée*, was used for fishing, as well as shore patrols and privateering. They served a similar role to the British cutter and American schooner. In the

United States, a lugger generally referred to a single-masted coastal sailer that could be operated by a single pilot.

Ketch. The ketch is a 2-masted sailing vessel used for coastal trading and fishing. Originally rigged with square sails and used as gunboats, they evolved into fore-and-aft rigged vessels in the 19th century that were useful as a traders, trawlers, and packets. They differ from schooners in that the forward mast is taller than the mizzen.

Scow. A flat-bottomed, blunt-nosed cargo vessel designed for trade in coastal and inland waters. They used retractable centerboards for stability and could be beached to unload cargo. They typically had a main and a foremast with a fore-and-aft rig on both.

12.5.4. Sailing Vessels of the Mercantile Era

Ship. The term *ship* was used for all decked sailing vessels, but also referred to a specific type of large sailing vessel equipped with three or four masts and a bowsprit. The forward masts were all rigged with square sails and included main, top, topgallant, and royal (uppermost) sails. The sails on the aft mast were sometimes fore-and-aft rigged. Ship-rigged vessels are often referred to as “all ships” today and were historically known as “lofty ships.” Figure 12.4 shows a fully-rigged, “double topsail” ship.

Clipper. The famous clipper ships originated in the Baltimore shipyards and were named for their ability to clip through the water, as well as clip time off of ocean crossings. They were built for the China Tea Trade, as well as other routes and jobs where speed was of the essence. Clippers were fully rigged ships of two or three raked masts and could be schooner rigged or square-rigged. The distinguishing feature of the clipper ship was its streamlined shape, with a narrow beam and a concave bow that cut through waves like a wedge. Clippers reached their peak in the 1840s but declined after the Civil War, with the opening of the Suez Canal and the completion of the transcontinental railroad in the United States in 1869.

Schooner. The workhorse of the American coastal trade in the 19th century, the schooner is a fore-and-aft rig ship of two or more masts (Figure 12.5). It was often fitted with small, square topsails. Schooner rigs were used on smaller vessels in the early 19th century, but soon were employed on larger and larger vessels, with increasing numbers of masts. By the 1880s, schooners of 800–1,000 tons with 3–4 masts were not uncommon.

Bark (or Barque). A bark has three masts, with square-rigged sails on the fore- and main masts and fore-and-aft sails on the mizzen mast (Figure 12.6). It is typically smaller than a fully square-rigged vessel, although barks sometimes exceeded 1,000 tons.

Barkantine. The barkantine is a smaller version of the bark, with square sails only on the foremast and fore-and-aft sails on the main and mizzen. It was designed with a long, narrow body for easy maneuvering in inland waters.

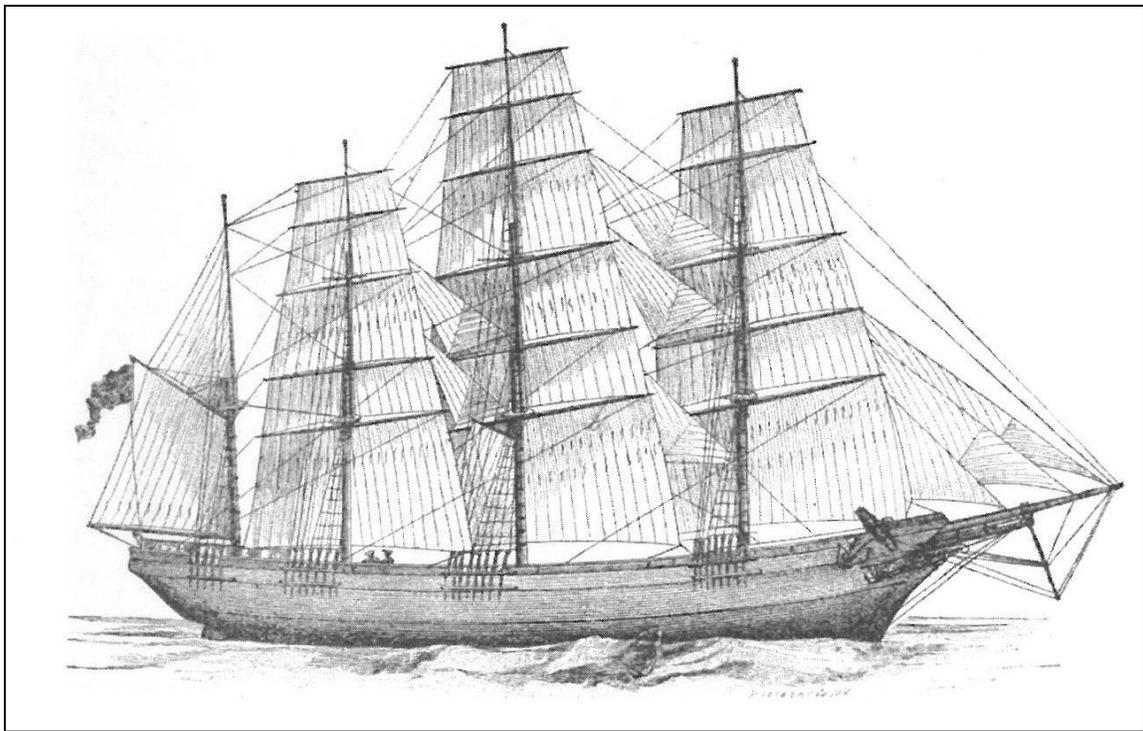


Figure 12.4. Four-masted, double topsail ship, commonly referred to as a “all ship” (U.S. Bureau of Marine Inspection and Navigation 1886).

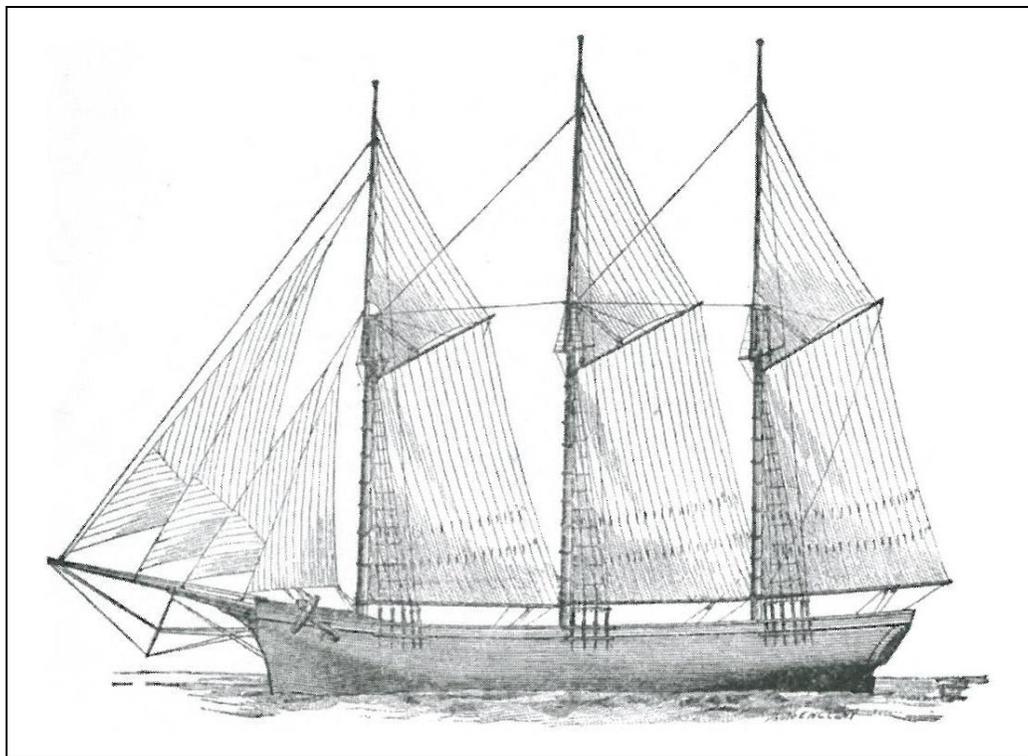


Figure 12.5. A typical schooner-rigged sailing vessel of the 19th century (U.S. Bureau of Marine Inspection and Navigation 1886).

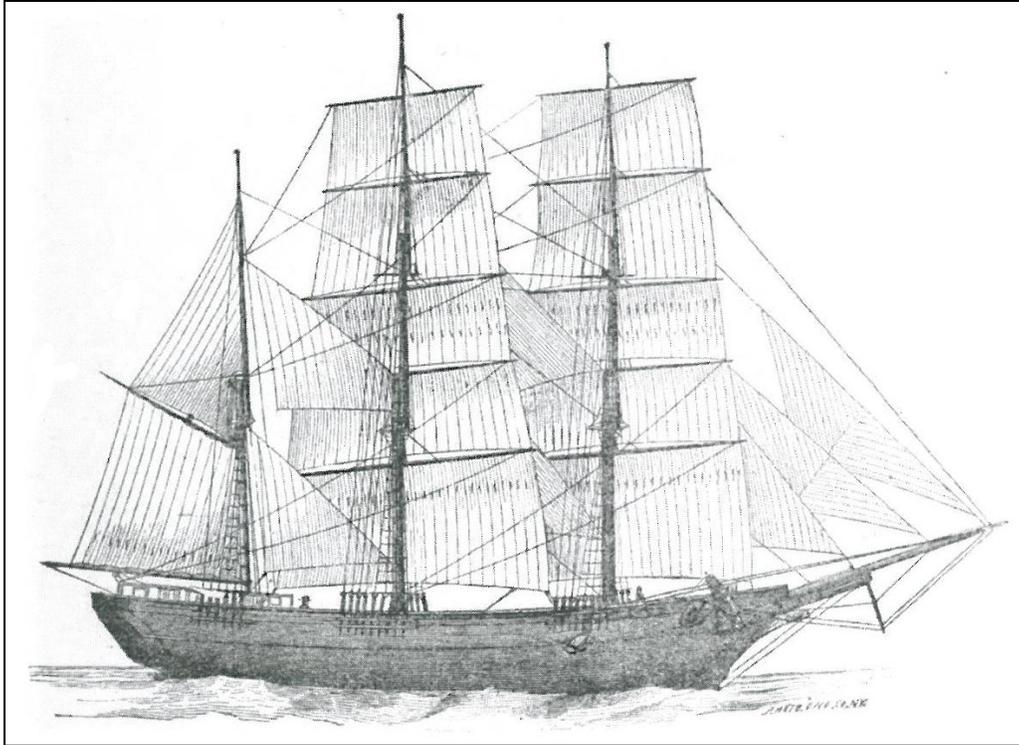


Figure 12.6. Bark-rigged vessel (U.S. Bureau of Marine Inspection and Navigation 1886).

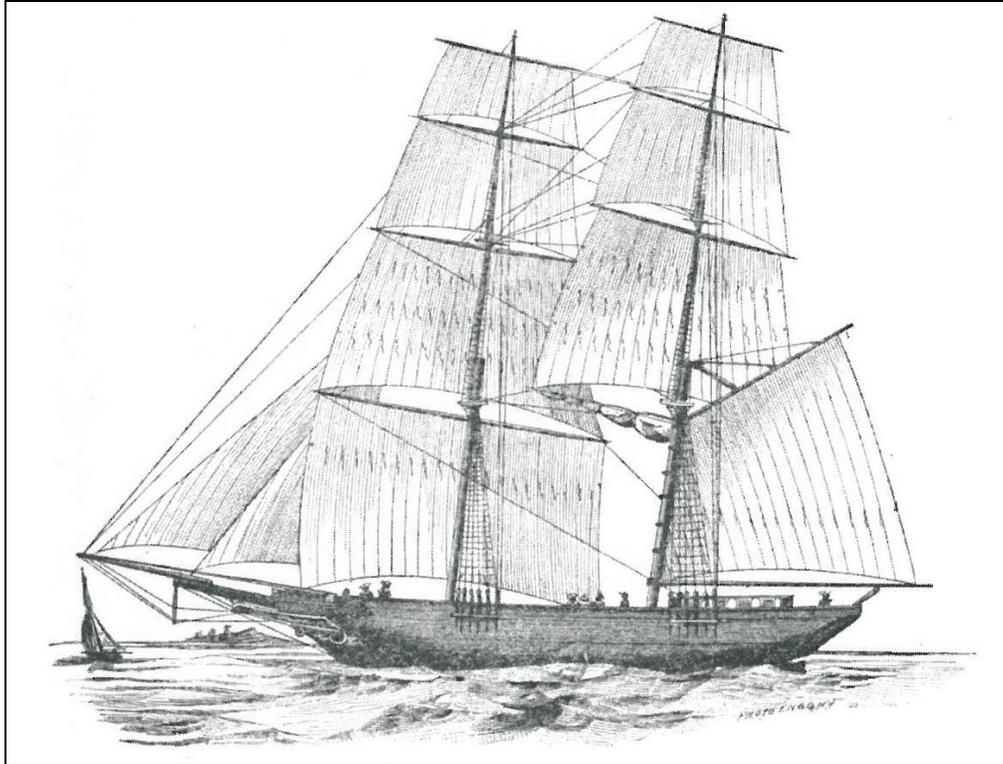


Figure 12.7. A typical brig of the late 19th century (U.S. Bureau of Marine Inspection and Navigation 1886).

Brig. A 2-masted, square-rigged vessel, designed for speed and maneuverability, the brig was a versatile ship. It was employed both as a fighting vessel and a merchant ship, and was most popular during the 18th and early 19th centuries. The mainsail was sometimes fore-and-aft-rigged, but with a square-rigged topsail and topgallant sail (Figure 12.7). On a hermaphrodite, or half-brig, the foremast was square-rigged and the mainmast was schooner-rigged (all fore-and-aft sails). The brig was similar to the scow, which differed only in having a square mainsail, with a spanker, or driver sail, attached by hoops to an auxiliary spar abaft (toward the stern of) the mainmast. The brig's spanker was larger and boomed, serving as the vessel's mainsail.

Brigantine. A brigantine is a smaller version of a brig that was rigged similarly to the half brig, but with a small topsail over the fore-and-aft mainsail. It actually falls between the half brig and brig in terms of the amount of fore-and-aft rigging on the main mast.

Sloop. Generally used for coastwise trade, but occasionally making ocean voyages, a sloop has one mast rigged with fore-and-aft sails, including a stay foresail rigged to the bowsprit. The sloop is easily handled by a small crew and is reliable in a variety of conditions.

Collier. The collier is a vessel designed to carry coal. Until the advent of steamships, coal was carried by brigs and other sailing vessels equipped with large holds. Only 300 to 400 tons of coal could be carried on these vessels. The steam collier emerged in the 19th century to transport coal to depots along trade routes where coal-fired steamships could refuel. These could carry as much as 6,000 tons.

12.5.5. Unpowered Vessels

Lighter. A lighter is a flat-bottomed boat used to transport goods between a cargo vessel and shore. They are towed or pushed by tugs and are used where deep-draught vessels cannot reach the docks.

Barge. Flat-bottomed vessels used for transporting goods, barges can be powered, but more typically on the Atlantic Seaboard were towed. Towed barges became common during the second half of the 19th century and carried bulk items that could be transported more inexpensively by boat than by railroad, including coal, sand, wood, and lime. Scores of these barges were lost in storms while transporting goods along the coast. Having no power, the barges were an encumbrance to the towing vessel in a storm and were frequently cut loose, leaving their small crews and the vessels at the mercy of the waves.

Schooner Barge. As steam vessels became more reliable in the late 19th century, old coastal schooners were converted to barges and towed by steam ships. In some cases the rigging was removed to create more usable space, but other barges retained their masts and might have used their sails in an emergency.

12.5.6. Steamships of the 19th and 20th Centuries

Paddlewheels. The earliest steam vessels were paddle-driven, with the paddles mounted on the stern or on the sides of the vessel. Advances in engine and propeller design led to a decline in new paddlewheel boats starting around the mid-19th century, although the requirement of certain

mail contracts for wooden-hulled, paddle-driven vessels kept them in service until after the Civil War. The design of these vessels varied greatly, but ocean-going steamers of the mid-19th century generally had a full sailing rig (bark or brig rigging), with the paddles and smokestack amidships (most commonly between the foremast and the mainmast). Figure 12.8 depicts SS *Sirius*, a paddlewheel steamer with a full sailing rig. They ranged from 500 tons up to the 5,888 tons of the Collins Line's *Adriatic*, built in 1856. The massive, 18,915-ton *Great Eastern*, built in 1858, was equipped with two 56-foot paddlewheels, as well as a single screw and six masts carrying 15,000 square feet of sail.

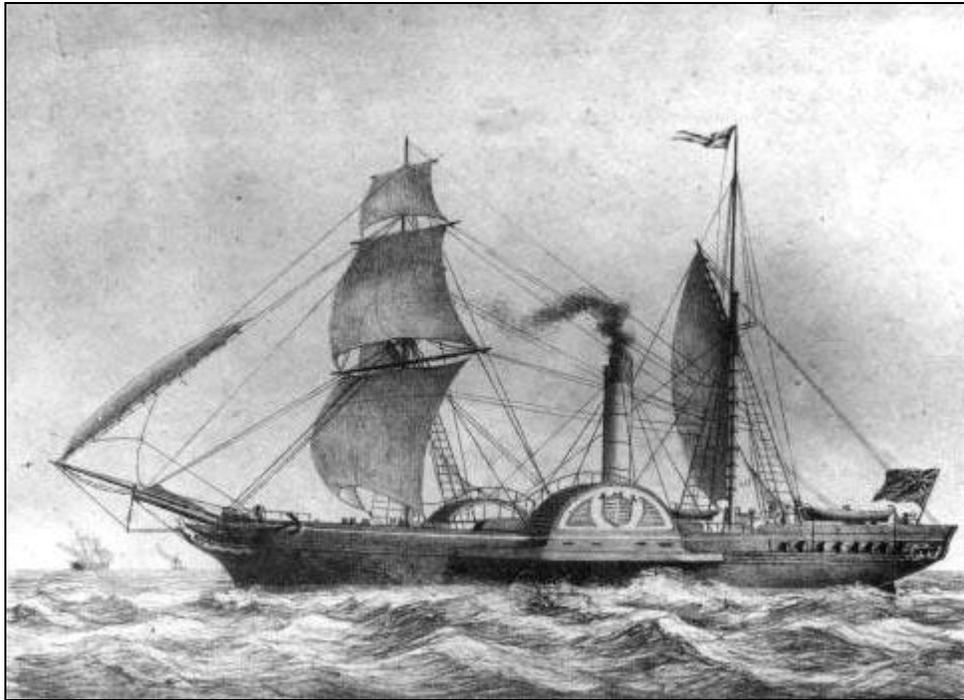


Figure 12.8. SS *Sirius*, which crossed the Atlantic in 1838 in 18 days (Wikimedia Commons 2008).

Screw-driven Steamers. Experiments with propeller- or screw-driven vessels date back to the late 18th century, but it was not until the 1830s that the first successful screw steamers were put into service in England. In 1840, S.S. *New Jersey*, built as *Robert F. Stockton* in England in 1838, became the first screw steamer to operate in U.S. waters. A variety of propeller designs have been used, including fully rotated screws and multi-bladed designs. Large ships were typically fitted with two propellers rotating in opposite directions to counter the effect of heeling torque, which pulls the bow of the boat in the opposite direction of the prop rotation.

Screw steamers were similar in appearance to their paddlewheel counterparts, with the exception of the lack of the paddlewheels and their casings amidships. In some cases, the engine and stack on screw steamers were located farther toward the stern, abaft the mainmast.

Passenger Steamers. The earliest steamships to carry passengers operated on rivers and inland waterways, including the famous Fall River Line that operated in Long Island Sound between New York and Fall River, Massachusetts. By 1850, steamships carried passengers between the major cities of the Eastern Seaboard. Passenger steamships often carried mail and

other goods at a premium freight rate because of their reliability and regularly scheduled service. The ships were designed with multiple decks to increase the number of berths available for passengers.

Steam Engines. The type of engine used on a vessel might be classified by its cylinder type or its driving mechanism. The earliest steam vessels used vacuum engines, which relied on the compression resulting from the condensation of cooling steam to move pistons. This was an inefficient method, since the amount of pressure generated was limited by the atmospheric pressure. Expansion engines were soon developed to drive locomotives and ships and were more commonly found on steam vessels than the vacuum engine. A simple expansion engine had only one stage of expansion, so that all the cylinders operated under the same pressure.

The invention of the compound engine in 1855 resulted in greater efficiency in the engine by expanding the gas in steps. The first compound engines used two stages, with later versions expanding to three and four stages. These engines would have compartments for the pistons and chambers that might be evident in the remains of a wrecked vessel.

Prior to the invention of the surface condenser, which allowed water to circulate through the engine in a loop, boilers were fed with salt water. This made it necessary to clean the boilers frequently. Samuel Hall developed the condenser in 1834, allowing the engine to have a looping system that brought the condensed steam back to the boiler. Prior to that date, the engines on steamers would not have a closed loop setup.

Most 19th century vessels used some variety of reciprocating drive, with turbine drives coming in after 1884. In a reciprocating drive, a piston moving in and out of a cylinder drove a mechanism linked to the drive shaft. The link on most paddlewheel steamers was a beam or sidearm linkage. The pistons drove an iron arm up and down on either end of a fulcrum, much like a see-saw. The cylinders were vertical and the heavy arm was located at the base, making the setup ideal for ships, which needed a low center of gravity.

12.5.7. Modern Motor Vessels

The development of the reciprocating marine diesel engine around the turn of the 20th century provided the last significant development for marine propulsion outside of experimental and nuclear craft. The diesel engine operates more cheaply and efficiently than a steam engine, occupies less space in the hold, and is easier to maintain, making it the ideal choice for vessels formerly powered by steam. The gasoline engine, with its greater thermal output, is more commonly used for smaller vessels with higher cruising speeds.

Cabin Cruiser. Ocean-going cabin cruisers are mid-sized recreational boats with an enclosed cabin providing accommodations for a small crew. They range in size from 25 to 40 feet, with larger versions generally referred to as yachts. They typically have a deck in front and an open well in the rear, with the cockpit on top of the cabin amidships. Early 20th century models were constructed of wood or metal, while fiberglass was introduced about 1950.

Yacht. The modern yacht is a large pleasure craft fitted with accommodations for passengers and crew. Motor yachts are vessels of over 40 feet in length. Luxury yachts can reach over 200

feet in length, but these are more in a class of Superyachts, or even ships. During the late 19th and early 20th centuries, a number of European royal families engaged in yachting, acquiring ever larger and more luxuriously appointed vessels to demonstrate their great wealth and style. Such conspicuous consumption was also practiced by international businessmen and American industrialists and financiers. Open water sport fishing vessels with enclosed cabins are often referred to as yachts and are typically 30–60 feet in length. During the first half of the 20th century, yachts were made primarily of wood or metal, but since about 1960, many are made of fiberglass.

Trawler/Seiner/Fishing Boat. These boats are generally screw-driven with booms and winches for deploying trawling and seining nets, a working deck, storage holds below decks for the catch, and a superstructure for the pilot house and crew accommodations. They have a variety of different rigs and deck layouts depending on the type of task for which they are outfitted. Smaller boats typically have the working deck in the rear and the superstructure in the forward part of the ship. In trawlers, the booms are attached to a center mast and are lowered as outriggers. This layout is common in shrimp trawlers. Seining boats have a boom that is parallel to the keel for reeling in the net after it is closed.

Large factory fishing vessels may have a working deck midship and an aft superstructure. They use a type of outrigger called a beam trawl. Other trawling rigs include otter trawlers, pair trawlers (two boats pulling a single trawl), side trawlers, and stern trawlers. Some factory fishing boats use longlines (baited hooks), jigs, or gillnets. Most larger fishing boats are constructed of wood or metal, with fiberglass used for some smaller boats.

Pleasure Craft. Pleasure craft are a variety of undecked motor vessels that travel in the open waters of the ocean, including runabouts, pontoon boats, and skiffs, though most do not venture far beyond the 3-mile line marking federal waters.

Dive/Exploratory/Research Vessel. These custom-rigged vessels might have a variety of hull and engine configurations, and are equipped for open water diving or research. Dive vessels can be used for day trips or overnight and carry only a few passengers or dozens. Their decks are designed to accommodate scuba divers and their gear, and their sterns are often fitted with lowered decks and ladders to facilitate entry and exit.

Research vessels carry data collection equipment that might include remote sensing devices, sample collection equipment, and climate and water monitoring devices. They can range in size from 40-foot cabin cruisers with a handful of crew to 200-foot multi-decked ships with dozens of crew members. Research vessels are operated by private foundations, universities, government agencies, and military organizations. Major types of research vessels include hydrographic survey, oceanographic research, polar exploration, and fishing research vessels. Vessels with unusual hull types include icebreakers and SWATH (Small Waterline Area Twin Hull) catamarans with submerged hulls like RV *Kilo Moana*, an oceanographic research vessel of the University of Hawaii.

Cutters. Originally a term used for a small, fast coastal sailing vessel, the term came to be applied to a broad class of vessels that includes patrol boats, buoy tenders, and rescue boats.

Cutters generally refer to vessels operated by the U.S. Coast Guard (Figure 12.9). These types of working shore boats can vary greatly in terms of hull shape, deck configuration, and propulsion.

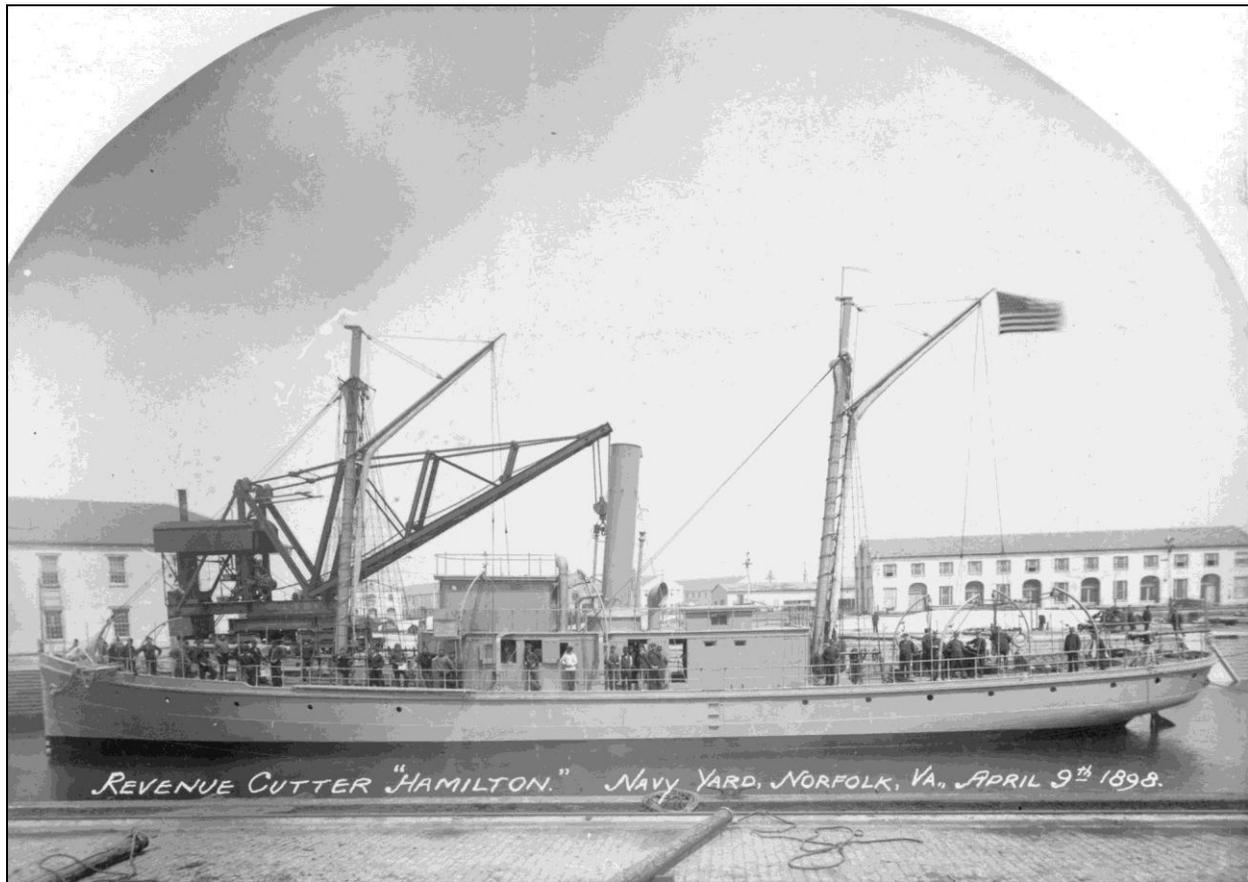


Figure 12.9. Coast Guard cutter *Hamilton*, a typical coastal patrol boat, in the Navy Yard in Norfolk in 1898 (courtesy of U.S. Coast Guard Historian's Office).

Pilot Boats. Pilot boats fall within a range of 20–75 feet and are designed to be fast and durable to withstand heavy seas and frequent bumping with large vessels when transporting a pilot to a ship to be brought into harbor.

12.5.8. Modern Sailing Vessels

Sailboat. Personal, recreational sailing vessels without enclosed cabins are commonly referred to simply as sailboats. They have simple sail plans that can be easily operated by a crew of one or two.

Sailing Yacht. A sailing yacht might be any size vessel that includes accommodations for the crew, usually 25–40 feet in length. Sailing yachts are typically single-masted, fore-and-aft rigged vessels with foresails and a spinnaker, the large, triangular sail deployed in front of the vessel when sailing downwind. Larger luxury yachts might have more complex rigs.

12.5.9. Modern Work Vessels

Freighter. Modern, ocean-going freighters can be as long as the length of three football fields and can reach nearly 100,000 gross tons. Container ships are designed to carry standard-sized containers. The containers are typically the size of a truck trailer and can be loaded onto a flatbed without unloading the contents. Freighters are often equipped with cranes for loading and unloading cargo, although container ships are usually unloaded with gantry cranes in port.

Tanker. Vessels designed to carry liquid in large holds have existed since at least the 19th century and have carried wine, molasses, and oil. Tankers have evolved to include a variety of vessel sizes, with some supertankers in the Ultra Large Crude Carrier class exceeding 200,000 gross tons and over 1,000 feet in length. These mammoth vessels cannot fit through the Suez or Panama canals and must travel around the capes of Africa and South America to travel between oceans. Crude tankers are designed to carry raw crude from their extraction point to refineries. Smaller vessels, known as product tankers, are designed to carry refined products from processing facilities to market. They range from 10,000–60,000 deadweight tonnage.

Tug. These vessels are specifically designed to tow or push barges or other vessels. They typically have high bows and a short forward superstructure. The engine occupies a large part of the vessel's usable space, but modern tugs are often equipped with firefighting equipment as well. Tugs today have diesel engines, but the earliest examples had steam engines. Power and maneuverability are critical on a tug, so the drives often have multiple screws or directable thrust. Harbor tugs might range up to 500 tons and have 2,500-h.p. engines, while ocean-going tugs might be 2,000 tons and have 15,000-h.p. motors. The larger tugs are used for rescue and salvage of distressed ships, as well as for towing off-shore drilling rigs and work platforms.

Drilling Rig/Oil Platform. Not technically vessels, these large work stations might nevertheless contain living quarters, scientific equipment, and marine-related vessels. They can be fixed to the ocean floor or floating and have collapsed, toppled, and capsized. Radio towers and other communications towers have also become underwater wreckage. The Texas Tower, a dive site off Long Island, is an Air Force radar platform built in 1955 that collapsed in a storm in 1960.

12.6. SHIPWRECKS

12.6.1. Number of Shipwrecks in the Atlantic OCS Survey Area and Preservation Potential

The number of shipping losses during the historical period in the Atlantic is staggering. Earlier estimates for the number of shipwrecks off the Atlantic coast ranged from 15,000–20,000 (SAI 1981:III-19), but the totals can vary widely based on the criteria used in compiling the list. Approximately 10,500 entries are included in the ASD. The IRSS database includes approximately 12,400 listings and includes wrecks in both near-shore and open water. According to Bascom (1976), only 10–20 percent of historic losses were in open water, with the remainder occurring on shore or on submerged rocks, reefs, or bars. This would mean that for a database such as the IRSS, only 1,500–2,500 wrecks are located offshore. However, some rocks, reefs, and bars are more than three miles from shore. Furthermore, primary source research for the

current investigation produced hundreds of wrecks that had not been listed in previous databases, and certainly others remain that have not been cataloged. Among the earliest compiled statistics are those of the volunteer life-saving service established on the New York and New Jersey shores, where the service reported approximately 500 shipwrecks between 1839 and 1848 (U.S. Life-Saving Service 1894). Although this figure may represent a peak period for shipwrecks, falling in the golden age of maritime trade and predating a number of modern developments in navigation and shipbuilding, extrapolating from these statistics over a coastline seven times longer and over a period of 50 decades, it is not hard to conclude that the number of ships lost would be in the tens of thousands. Therefore, a figure well over 10,000 does not seem unreasonable for wrecks within the OCS project area.

The number of reported shipwrecks is considerably greater than the number of extant wrecks on the ocean floor, however. Ships that went to pieces on bars or in severe storms did not leave intact remains on the bottom. Although parts of these ships might be recovered at some time, it is unlikely that they will ever be identified or yield significant historical information. Shallow wrecks were often recovered by salvors, sometimes years after the disaster. Although ships that sank in open water are more likely to remain intact and are less susceptible to damage after sinking from storms, currents, and wave action, many of the ships lost in the Atlantic OCS have been covered by shifting sands, eroded by water and abrasion, corroded by chemical and organic processes, or carried away by currents and tides, and are unlikely to ever be found.

Shipwreck preservation on the OCS between the 3-mile territorial waters of the Atlantic seaboard states and the shelf break is related to a broad spectrum of environmental factors that vary from Maine to Florida. Over that area water temperatures vary considerably. Overall, colder waters of the Labrador Current that parallel the coastline north of Cape Hatteras contribute to better preservation than waters warmed by the Gulf Stream south of Cape Hatteras. Differences in temperature also have an effect on various types of biological activity that impact organic and inorganic preservation at shipwreck sites. Water depths are also a significant consideration in shipwreck site preservation. In the most general terms, the deeper a site is found, the better it is likely to be preserved. Depth can be related to additional factors that play a role in preservation such as temperature, salinity, oxygen, sunlight, and motion dynamics. The nature of sediments also varies from north to south on the OCS. Rock and gravel bottoms more prevalent in the north do not necessarily provide the level of protection afforded by sand, silt and mud, which are more often found along the Middle and South Atlantic seaboard. Bottom conditions are also regionally specific. In the northeastern OCS, extensive sandbanks can be found offshore while to the south, areas of hardbottom can be found. Where wreck remains are covered by accreting sediment, preservation is generally much better. The more rapidly a shipwreck is buried, the more likely it will be well preserved.

Shipwreck preservation also depends on the type of vessel and the nature of its loss. In wooden vessels, preservation can depend on the type of wood used. Some woods are more resistant to deterioration than others. Cedar and teak often have a greater resistance to decay than pine and spruce. Oak, a much preferred shipbuilding material due to its strength, is also subject to rot, and unlike cedar and teak, is attractive to various marine organisms such as *Teredo navalis*, a mollusk in a group of organisms known as shipworms. Fasteners can also have an impact on structural preservation; brass and bronze having greater resistance to salt water than iron. Wooden vessels can also be more heavily impacted by extreme surface conditions that can

break up the structure. Unless weighted down by ballast, cargo or ordnance, the fragmentary remains of a wreck can float, distributing structural elements over a broad area. Once deposited on the bottom in water depths as deep as 200 feet, surface conditions can continue to impact structural remains.

Iron-hulled vessels may have a higher potential for structural integrity, but they are not necessarily more resistant to the forces of nature than wooden ships. Dissimilar iron used in plates and rivets can be highly electrolytic. Electrolysis is one of the major causes for iron and steel vessel deterioration. When iron and steel hulls begin to break up they have no natural buoyancy as wood does. That can serve to localize the distribution of structural material. Once on the bottom, electrolytic reduction, inorganic processes, and transferred surface motion contribute to the destruction of exposed structure. Like wooden vessel remains, iron and steel shipwreck materials can be better preserved by burial. Although cold water appears to contribute more to metal hull preservation than warm water, the combination of cold, depth, and lack of sunlight appears to create ideal conditions for inorganic deterioration.

Vessel structure composition and the elements are not the only factors that impact preservation on the OCS. Human activity can be equally destructive. Perhaps the most destructive is trawling and dredging. Serious damage to shipwreck sites has been attributed to trawling. The effects of nets fouling an exposed wreck can be highly destructive. Dredging for shellfish such as scallops can be equally destructive. Although today surveys are required in advance of construction activity, burial of cables and pipelines has been determined to impact shipwreck remains. As dredging activity associated with seafloor minerals and aggregate increases, the potential for shipwreck disturbance is going to increase. Finally, diving and even submersible access to the OCS has placed shipwrecks within the grasp of recreational wreck divers and commercial salvors willing to recover both shipwreck remains and the artifacts associated with those vessels.

In spite of the numerous factors that can compromise the integrity and long-term preservation prospects of shipwrecks, thousands of wrecks have been documented and remain on the OCS. In few cases have actual surveys been conducted to assess the condition of the remains.

12.6.2. Shipwrecks by Vessel Type and Period

A total of 5,176 ocean-going vessels (i.e., excluding aircraft) from the ASD are identified by vessel type. Of the 64 vessel types recorded, only 13 had over 100 entries and accounted for 80 percent of the total entries. Schooners, barges, steamers, freighter/cargo, fishing vessels, and brigs were the six most common types. Schooners were by far the most numerous (1,765), making up 34 percent of all entries in the ASD. Barges were a distant second (495 or 9.6 percent). The vessel types were grouped by the year of the wreck in 25-year increments to illustrate the changes in vessel types over the years. The distribution of wrecks by time period is shown in Table 12.1. (Table 12.1 has only 61 categories because entries for tugboat, towboat, and tug/towboat were combined, as were cargo and freighter). Of the 4,291 wrecks with known vessel type and for which a date of loss is given, about half (48.2 percent) wrecked in the 20th century. Better reporting of shipwrecks, the large number of vessels, and the loss of large numbers of freighters, steamers, tankers, and barges to German submarines in World War I and World War II seem to account for this.

Some vessel types occur over long periods of time, such as the schooner, sloop, and brig, which were adapted to different uses while retaining the same name. Steamers first appear in the wreck record in the second quarter of the 19th century and continue into the second quarter of the 20th century. Although most vessels built after 1910 were equipped with diesel engines, steamships still played an important role in maritime trade in the 20th century. The peak of losses for steamships occurred in the period from 1850 to 1874 when 111 wrecks were reported, many of them Civil War losses. The 67 steamer losses in the first quarter of the 20th century are largely from U-boat attacks.

Table 12.1. Vessel Types in the ASD by Historical Periods.

	<1700	1700-1724	1725-1749	1750-1774	1775-1799	1800-1824	1825-1849	1850-1874	1875-1899	1900-1924	1925-1949	1950-1974	1975-1999	2000-2010	unknown	Total
Barge					1			2	13	86	91	22	4		276	495
Barkentine								4	13	6						23
Barque						1	6	45	39	8					3	102
Battleship										7						7
Boat					2			2							4	8
Brig	1		1	15	10	47	41	45	29	5	2	1			3	200
Brigantine	1	4	1	6	6	3	3	12	6	1	3					46
Buoy tender													1			1
Cabin cruiser											1	3			4	8
Canal boat									6	1	1					8
Collier										1	3					4
Corvette								1								1
Crewboat															1	1
Cruiser										3		1				4
Cutter					1					2	8		3		3	17
Destroyer										1	7	29	8		8	53
Dive tender													1			1
Dredge										2	2		1		10	15
Drilling rig/ship															2	2
Escort											2	26	3			31
Ferry								1	1				4		2	8
Fishing vessel						3			1	4	14	24	41		118	205
Freighter/cargo									11	49	125	13	21		35	254
Frigate					15	7	1	10		1		1			3	38
Galleon	2		2	1	1					1					3	10
Gunboat					1	31		4		3	4				2	45
Landing craft										1			1		39	41
Landing ship											1	1	1			3
Landing ship, tanks										1	11	12			1	25
Liberty ship											2	1	1		10	14
Lighter									1	3	14	1				19
Lightship								2	1	1	2	1			4	11
Merchant ship		2	12	18	7	3		4			9					55
Mine sweeper											4	3			1	8
Monitor/ironclad								9								9
Motor vessel									1	3	10	1			4	19
Man-o-war	1					1										2
Paddlewheel boat							1			1					3	5
Passenger							1		2	5	7	4				19

Table 12.1. Vessel Types in the ASD by Historical Periods (continued).

	<1700	1700-1724	1725-1749	1750-1774	1775-1799	1800-1824	1825-1849	1850-1874	1875-1899	1900-1924	1925-1949	1950-1974	1975-1999	2000-2010	unknown	Total
Patrol									1	42	26	3			3	75
Pilot boat					1	1		8	4	2	5		1		7	29
Pleasure craft											3				1	4
Sailboat	2		1				2			10	2	1			22	40
Schooner	2		3	23	31	103	133	293	542	443	114	13	2		63	1,765
Schooner barge									19	87	13	1			14	134
Scow									1	5	3	2			3	14
Ship	7	2	5	3	10	30	13	24	1	3			1		11	110
Ship of the line					1	1		4								6
Shrimp trawler													1		8	9
Sidewheeler						1	2	26	8	10	5		1		1	54
Sloop	2	7	7	13	25	28	18	14	20	33	6	5			7	185
Steamer							4	111	66	67	19				19	286
Submarine								2		20	33	17	8		17	97
Supply vessel					8						2	1	1			12
Tanker										7	83	9	5	1	18	123
Torpedo boat										13	6				1	20
Transport					23			2		3	1	2			6	37
Trawler										11	38	15	9		28	101
Tug or towboat								4	13	14	18	4	15		112	180
Whaler								24								24
Yacht									1	13	30	3	2		5	54
Totals	18	15	32	79	143	260	225	653	800	979	730	220	136	1	885	5,176

Other peak periods of loss for vessels also seem to have been influenced by war losses. For example, the 28 sloops known to have been lost in the first quarter of the 19th century likely resulted from naval combat associated with the War of 1812 and ongoing maritime conflicts with European nations. The number of sloops lost peaked again in the first quarter of the 20th century, which included World War I when German submarines trolled the waters of the Atlantic Seaboard. Reported losses of ship-rigged vessels and gunboats peaked during the first quarter of the 19th century, also likely related to engagements during the War of 1812. The greatest number of losses for barges and freighter/cargo vessels was during the 25-year period that included World War II, when German submarines again stalked U.S. merchant ships along the coast.

Because of their specialized nature, the wrecks of many vessel types were confined almost entirely to the 20th century, including the tanker, fishing vessel, submarine, trawler, tug boat, and dredge. The sailboat, yacht, pleasure craft, and motor vessel were primarily privately-owned vessels, and were generally limited to the 20th century. At the other end of the timeline, relatively few early vessels (prior to 1775) are referred to by ship type, with only 144 vessel types noted in the ASD for that period.

12.6.3. Analysis of Shipwreck Locations

The shipwreck inventory for the Gulf of Mexico (Pearson et al. 2003) included a model of the spatial distribution of shipwreck locations in the BOEM Gulf of Mexico Region based on data collected for that report. The report points out the many difficulties of working with

shipwreck data, including inaccurate and incomplete reporting, under-reporting of smaller vessels lost, historical variations in ship and place names, and confusion regarding similar names for ships and geographic locations (Pearson et al. 2003:4-2–4-6). Previous shipwreck location models by Pierson et al. (1987), SAI (1981), and Garrison et al. (1989) are cited that produced mixed results. Pierson et al. (1987) and SAI (1981), which examined the southern Atlantic Seaboard for an earlier MMS study, found shipping routes, port locations, and natural hazards to represent causal factors in the location of shipwrecks. Garrison et al.'s (1989) study of shipwrecks in the Gulf of Mexico conducted factor analysis on temporal and areal distribution. According to Pearson et al. (2003:4-42–4-43), the Garrison et al. (1989) study found an association between shipwreck location and the development of port locations over time, as well as between shipwreck locations and the location of shipping routes, ports, and hazards.

In general, however, these associations were weak as a result of inaccurate locational information for a large number of reported wrecks. For this reason, Pearson et al. (2003) did not emphasize such factor analysis. In their study of shipwreck distribution in the Gulf, they found broad patterns of wreck distribution, with the vast majority of wrecks located near shore inside the 60-meter water depth contour. There is also evidence of increased occurrence in the vicinity of ports, in areas of heavy traffic, such as the Straits of Florida, and near hazards, such as the reefs around the Dry Tortugas. They also found a greater concentration of wrecks in the eastern part of the Gulf, most likely because vessel traffic has been greater in that area for a longer period. However, the lack of documentation for a shipwreck in a particular location does not preclude the presence of one or more wrecks. A number of BOEM-permitted actions in the Gulf of Mexico, for example, resulted in the discovery of shipwrecks in locations where such resources were not expected based on probability modeling (e.g., Atauz et al. 2006; Church and Warren 2008; Ford et al. 2008). Because of the number of significant historic shipwrecks that have been identified outside of high probability zones, a predictive model approach to shipwreck locations is not a recommended management strategy.

The current study's findings support the limitations of a predictive model approach. For every lease block where one shipwreck has been identified far from a port or navigational hazard, some number of lease blocks with no known shipwrecks also contain wrecks. Such lease blocks cannot be discounted as potential sites of significant resources. Nevertheless, the distribution of identified wrecks does suggest that certain geographic variables are correlated with shipwreck frequency, such that certain locations can be expected to have more wrecks. These include proximity to shore, proximity to ports or confined navigational routes, and the presence of navigational hazards. Plotting the locations of identified wrecks illustrates the extent to which shipwrecks are concentrated near shore, near ports, along navigation routes, and around hazards. Because different methods were used in compiling existing databases and the current ASD, shipwreck locations from these inventories were plotted separately as well as in combination to see if patterns of shipwreck location were consistent across different lists. Mapping wrecks from different sources separately makes clear some the geographical biases inherent in particular sources. Recognizing the biases in the sources helps put the overall ASD into perspective and emphasizes the limitations of this data set as a basis for predictive modeling. Figures 12.10–12.14 illustrate the distribution of shipwrecks in the OCS study area from various sources. Only those entries that provided coordinate locational data were included.

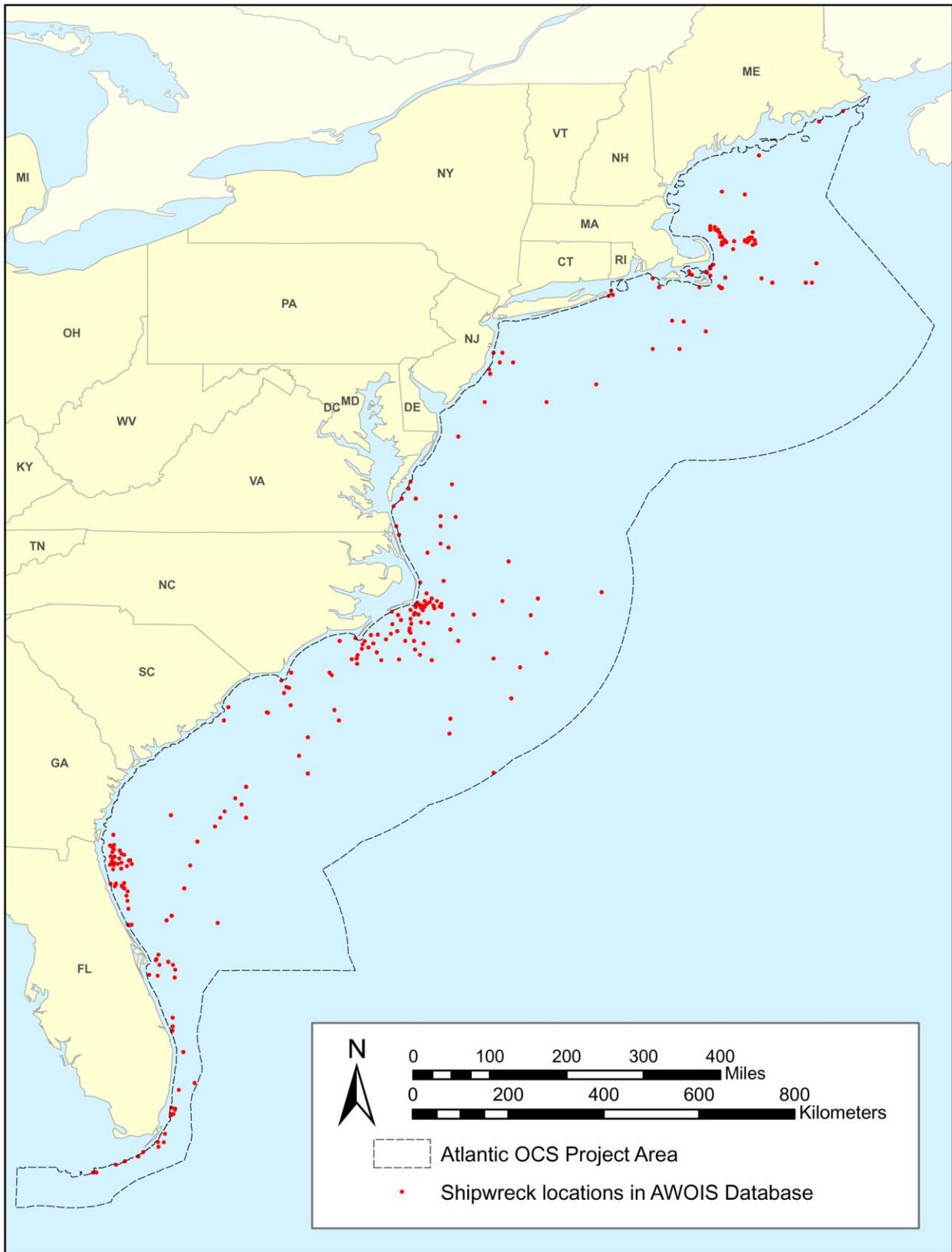


Figure 12.10. Location of shipwrecks with coordinate data in AWOIS database.

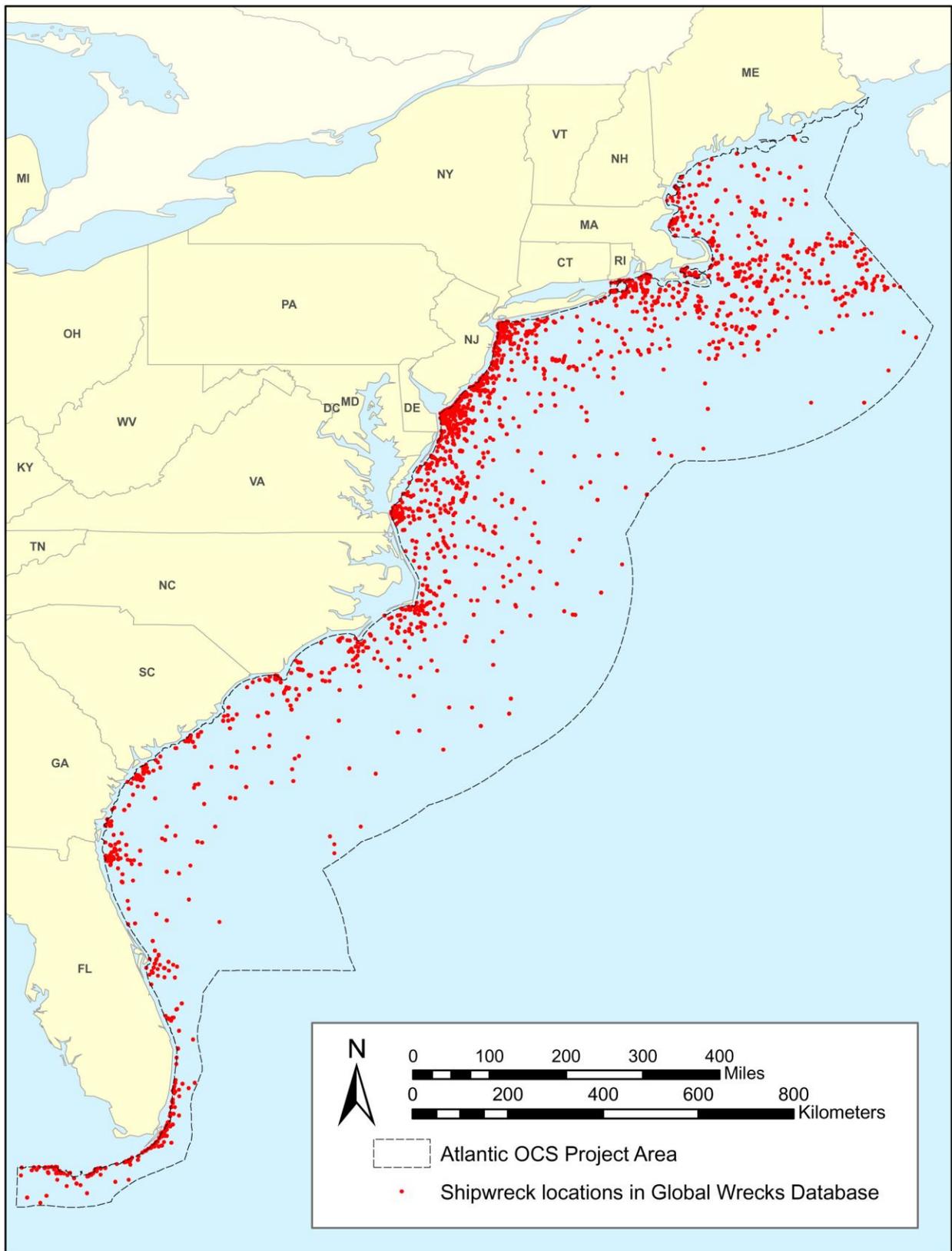


Figure 12.11. Location of shipwrecks with coordinate data in the Global Wrecks database.

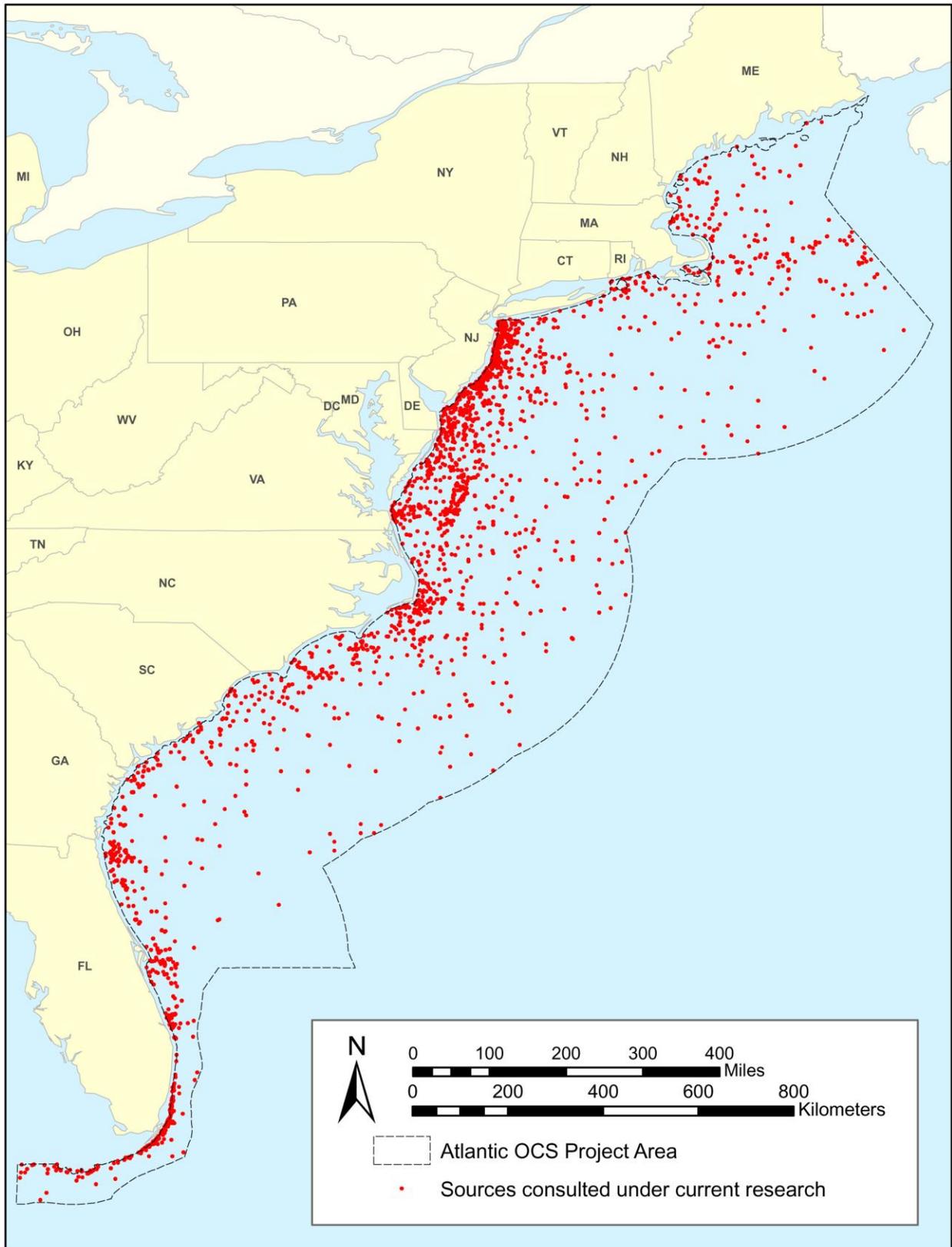


Figure 12.12. Location of shipwrecks with coordinate data from primary and secondary sources.

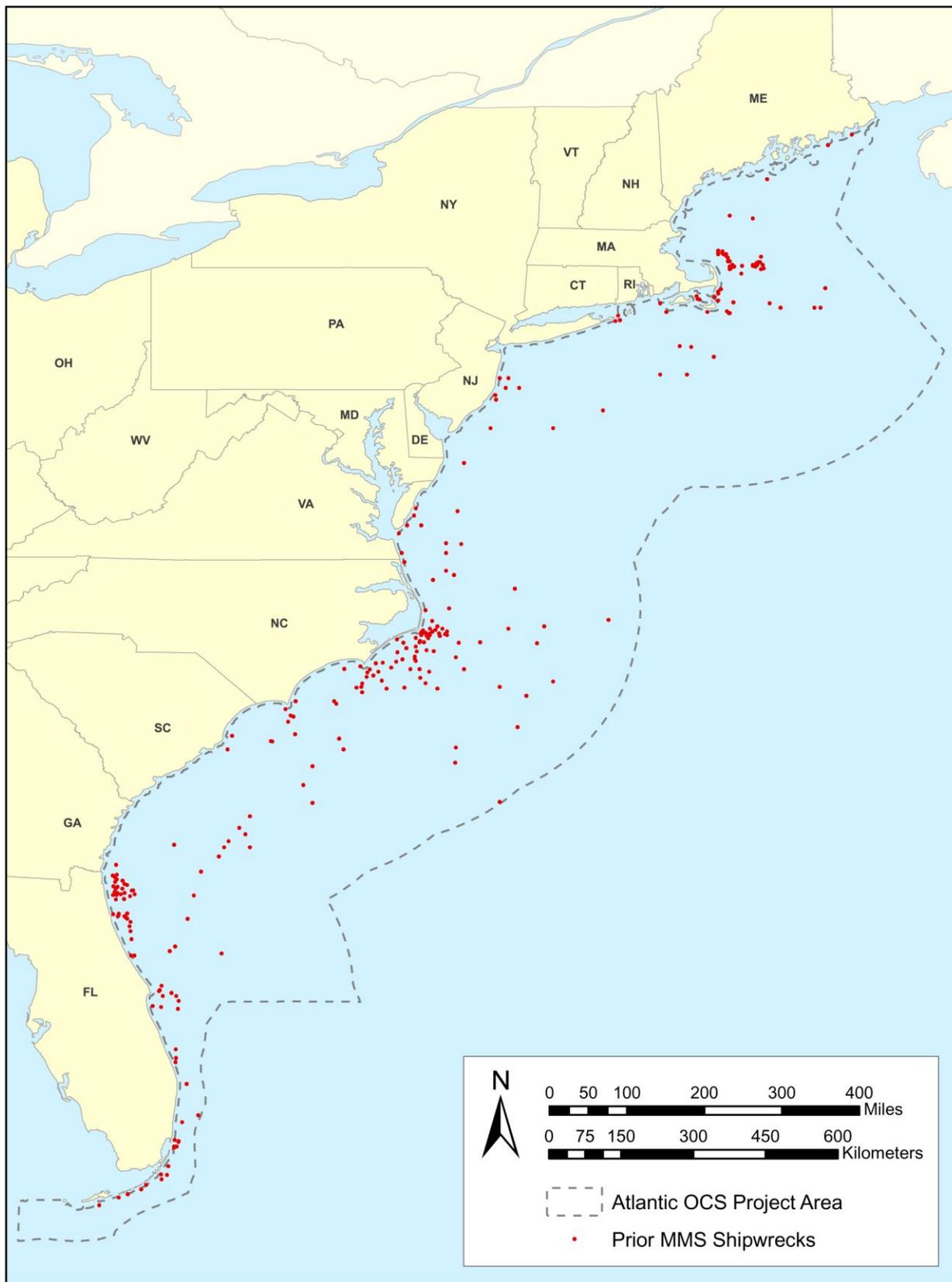


Figure 12.13. Location of shipwrecks with coordinate data from the existing BOEM database.

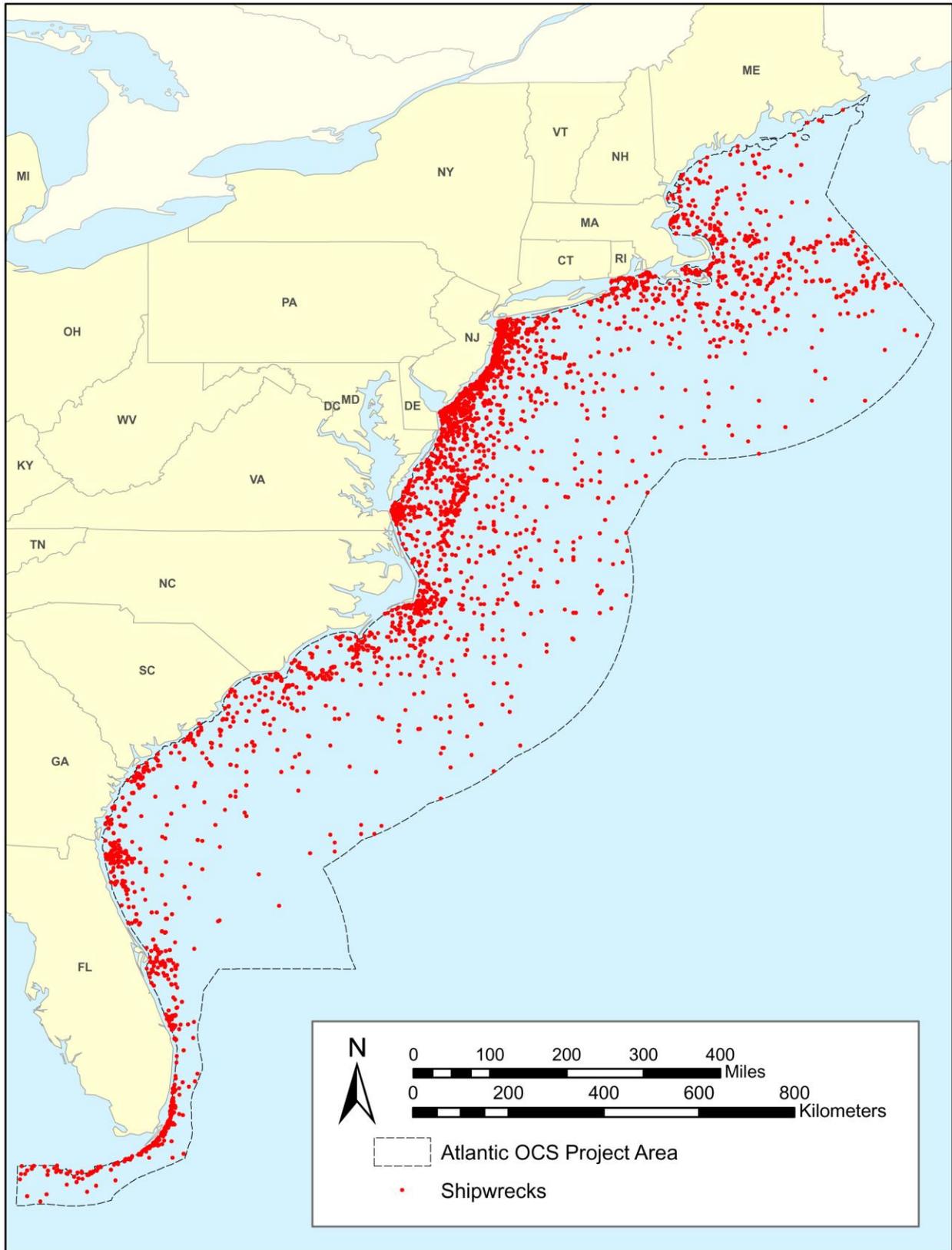


Figure 12.14. Location of shipwrecks with coordinate data from all sources in the ASD.

Figure 12.10 shows the location of wrecks from NOAA's AWOIS database. This list is based on actual features identified from surveys and does not include wrecks reported but not located. However, it does include some features identified from survey data that may not be shipwrecks but some other type of feature on the ocean floor. It is evident from the distribution on this map that the vast majority of shipwrecks are located within 50 miles of shore, with the greatest localized concentration off the coast of New Jersey, Delaware and Maryland. Significant clusters of wrecks are also located around Cape Cod, the entrance to Chesapeake Bay, the North Carolina capes (Hatteras, Lookout, and Fear), and the entrances to the Savannah and St. John's rivers. Farther from shore, wrecks are more widely distributed, with noticeable concentrations around the Georges Bank fishing grounds and off of Cape Hatteras. The Global Wrecks database, a commercial shipwreck inventory compiled by General Dynamics (and not included in the ASD), has more entries but shows a nearly identical distribution to the AWOIS list (see Figure 12.11).

Figure 12.12 shows the distribution of shipwrecks from primary and secondary sources consulted during the current research effort (excluding AWOIS). Because a large number of these wrecks come from regionally specific dive guide books, the distribution is heavily skewed toward wrecks in the Mid-Atlantic region, from Long Island, New York to Chesapeake Bay, Virginia. There are also a large number of wrecks reported for Cape Hatteras and Cape Lookout. Wrecks are apparently under-reported for New England (from which no specific dive book was included). Offshore wrecks appear to be fairly randomly scattered between New York and North Carolina.

The map of shipwrecks from the previous BOEM database shows clustering around the coast of Massachusetts, around Cape Hatteras, and at the mouth of the St. Johns River in Florida (Figure 12.13). This clustering likely is due to the extensive surveys conducted in these areas, where shipwreck locations have been assigned locational data.

Figure 12.14 shows all of the wrecks with locational information in the ASD, which includes governmental databases and primary and secondary sources. Combining the inventories mitigates some of the biases in the individual lists and reinforces the broad patterns evident on the other maps. Duplicate entries have been combined in the ASD, and thus do not skew the distribution. One bias worthy of note is the possibility that coordinate data are more likely available for wrecks closer to shore, such that wrecks further offshore may be underrepresented.

The distribution maps presented above demonstrate that patterns of wreck location are similar using a number of different data sources. Vessels travelled to and from myriad locations along the Atlantic Seaboard during the historic period, and even though ships followed certain routes, they often sacrificed safety to take a shorter route, made navigational errors, or were blown off course. As a result, shipwrecks can be found in almost any part of the project area. Nevertheless, the distribution of known and reported shipwrecks on the Atlantic Seaboard is clearly not random. The distribution of shipwrecks with unknown locations obviously cannot be determined, but the available information on wrecks with known locations can nevertheless be useful for cultural resources management purposes.

Plotting shipwrecks with known or reported locations reveals that shipwrecks are concentrated in certain geographic areas. Such information may have no bearing on whether a

wreck is present in a particular location, but it could guide expectations about the relative likelihood that wrecks are present in one area versus another.

To explore this proposition, shipwreck density was measured within 2,304-hectare BOEM lease blocks in the OCS from the AWOIS database, the existing BOEM Atlantic Shipwreck database, and primary and secondary data collected during the current effort; the results are shown on the map in Figure 12.15. Density is defined in three categories: no wrecks reported, 1–4 wrecks reported (low frequency), and 5 or more wrecks reported (high frequency). Beyond approximately 100 miles from shore, lease blocks with one or more wrecks are sparse and widely scattered, with the exception of the Georges Bank fishing grounds, located in an area 100–200 miles off the coast of Massachusetts. Only three high frequency lease blocks are farther than 100 miles from shore. One of these is in the Georges Bank area. The other two are off the coast of Cape Hatteras and are apparent outliers. Within the approximate 100-mile boundary, the density of low frequency lease blocks increases noticeably, and high frequency lease blocks cluster along certain portions of the coastline, especially near ports, estuary entrances, and navigational hazards. Between the Chesapeake Bay and New York City, the high frequency blocks run along the length of the coast and extend farther from shore along high traffic routes. Clusters of sites are evident south of New York City, off Cape Lookout, Cape Fear, and Cape Canaveral, and along the Florida Keys

Pairing the data points in the distribution map in Figure 12.15 with expectations about shipwreck frequency in relation to port entrances, shipping routes, and navigation hazards, it is possible to distill zones of low, medium, and high potential for shipwrecks (Figure 12.16). By no means should the area of low potential be accorded less protection from a cultural resource management perspective. Indeed, the paucity of known wrecks in that zone could reflect nothing more than the lack of systematic survey coverage in areas further off the coast. Similarly, shipwrecks occurring closer to shore were much more likely to be reported and, hence, recorded. However, recognizing areas that appear to have higher frequencies of wrecks, based on the distribution of known wrecks and geographic factors that contribute to wrecks, could offer useful management information insofar as applicants could be encouraged to avoid areas of high potential whenever possible. Over time, as additional survey data is obtained throughout the OCS, the zones depicted in Figure 12.16 can be refined.

Wreck locations were also compiled for each state based on the reported “Nearest State” entry to explore regional distribution of shipwrecks (Table 12.2). Of 8,614 wrecks in the ASD for which the nearest state was reported, the greatest number of wrecks was found closest to New Jersey (1,684). Virginia had the second largest number of wrecks with 1,637. North Carolina was third with 1,477 Florida also had nearly 1,000 wrecks (990).

Because of the great variation in the ocean frontage of each state, the number of shipwreck sites per mile was calculated based on an estimate of the length of the federal waters boundary for each state (see Table 12.2). By far the greatest concentration of sites per mile is found in the Mid-Atlantic states. Maryland has the highest ratio of shipwrecks with nearly 19 per mile of coastline. Despite a relatively long coast of 112 miles, Virginia’s 1,637 shipwrecks place it second with 14.62 sites per mile. New Jersey and Delaware also have a very high ratio of shipwrecks per mile. It was anticipated that the New England states would have a high ratio of shipwrecks per mile due to the high volume of ship traffic around Boston and the presence of

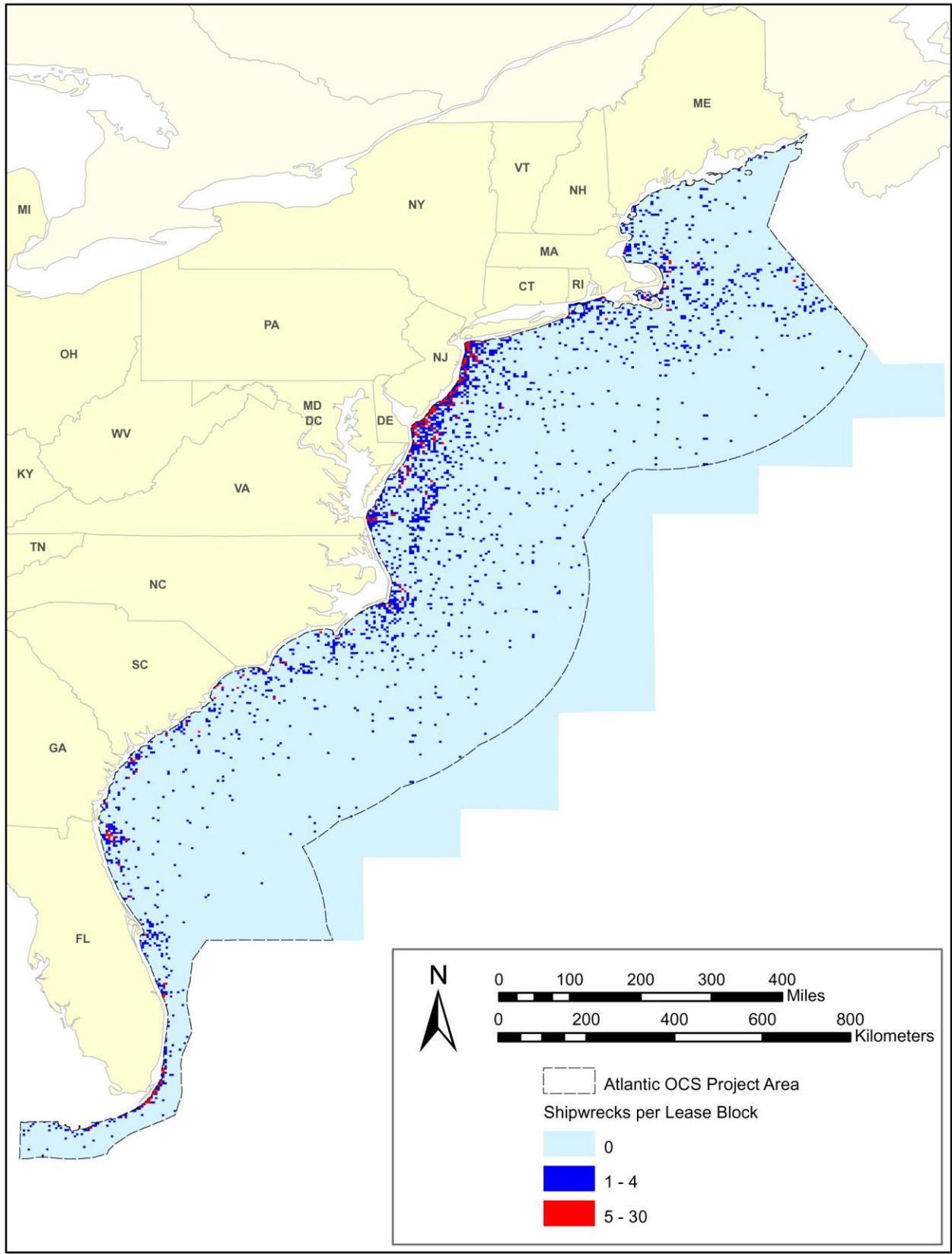


Figure 12.15. Shipwreck density map for BOEM lease blocks in the Atlantic OCS study area.

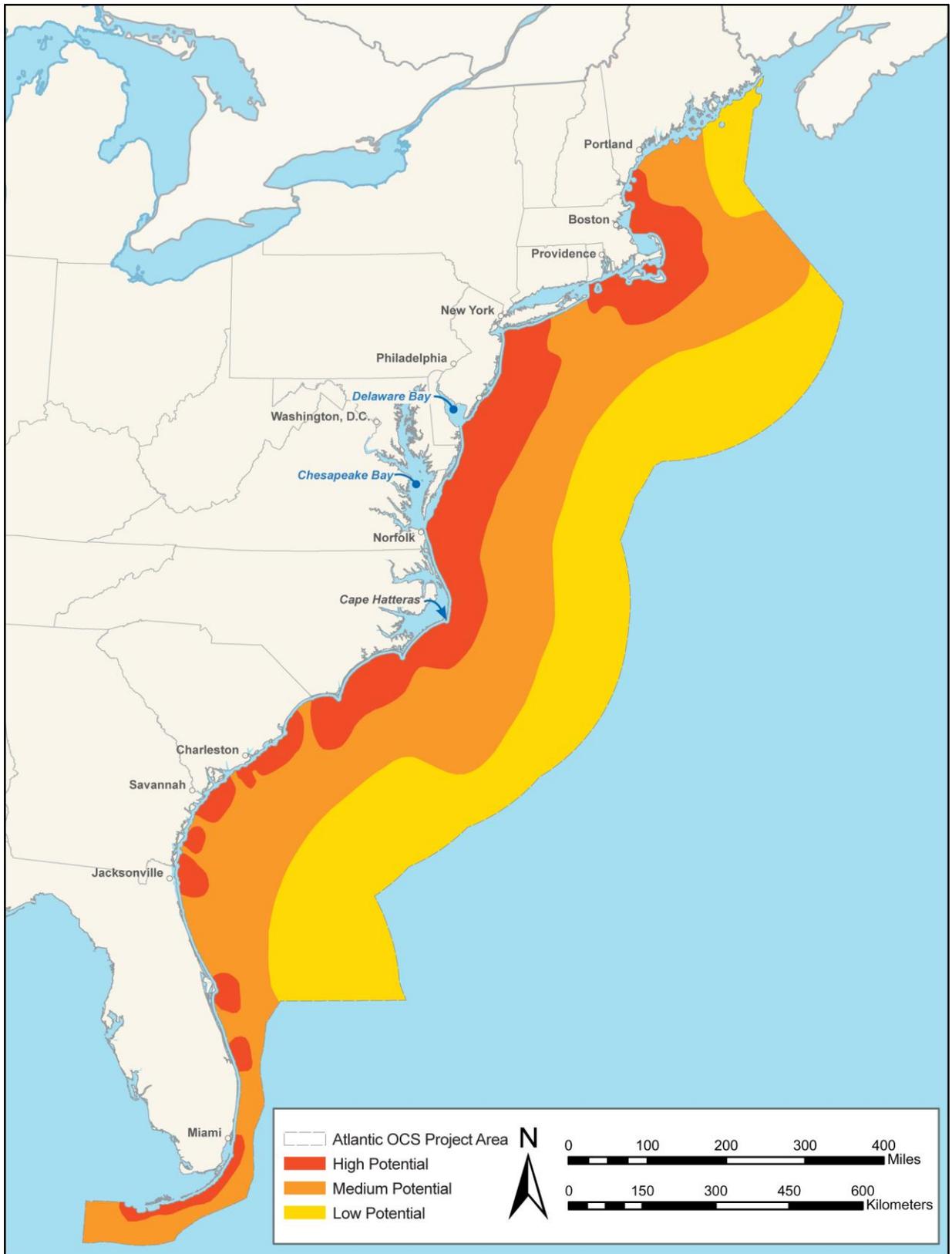


Figure 12.16. High, medium, and low potential for shipwrecks in the Atlantic OCS based on shipwreck density and geographic factors.

Table 12.2. Distribution of Shipwrecks in the ASD by State and Region.

Nearest State	Number of Wrecks	Miles of Shoreline in State	Sites Per Linear Mile	Region	Number of Wrecks	Miles of Shoreline in Region	Sites Per Linear Mile
ME	135	240	0.56	Northeast	1,026	539	1.90
NH	10	14	0.71				
MA	740	230	3.22				
RI	128	40	3.20				
CT	13	15	0.87				
NY	346	120	2.88	Middle Atlantic	4,579	308	14.87
NJ	1,684	130	12.95				
DE	295	25	11.80				
MD	617	33	18.70				
VA	1,637	112	14.62				
NC	1,477	320	4.62	Southeast	3,009	749	4.02
SC	408	185	2.21				
GA	134	97	1.38				
FL	990	635	1.56				
Totals	8,614	2,196	3.92				

navigational hazards around Cape Cod. However, the low volume of traffic along Maine’s 240-mile coast reduces that region’s average. The Southeast states have a surprisingly high density of sites with 4.02 per mile.

It appears that the distribution of wrecks within the Atlantic OCS project area is closely correlated to vessel traffic, especially in the vicinity of port approaches and navigational hazards. Consistent data on vessel traffic from ports on the Atlantic Seaboard over long periods of time is difficult to find and widely scattered in the sources, and most economic statistics of the Atlantic trade are concerned with the value of imports and exports rather than numbers of vessels or even tonnage (Evans 1976; Huebner 1922). Historical studies have also favored the Colonial period over the 19th and 20th centuries (Crothers 2004; French 1987; Matson 1998; Morgan 1989; Smith 2003). However, a reasonable understanding of vessel traffic in the Atlantic OCS is possible from the literature.

The British customs houses prior to the Revolution collected data on the total tonnage of vessels arriving and departing from each of the colonies in 1769, broken down by origin and destination (Johnson 1922:92). These figures provide a broad picture of the most popular trade routes. For the New England colonies, New York, and North Carolina, the greatest tonnage of vessels arrived from other colonies and from the Bahamas. In New Hampshire, Pennsylvania, and Georgia, the largest tonnage of vessels arrived from the West Indies. For Maryland, Virginia, and South Carolina, the greatest amount of tonnage of vessels was from England and Ireland. The tonnage of exports showed a similar pattern: New England exported primarily to the rest of the colonies, the Bahamas, and the West Indies, while the Mid-Atlantic and Southern states exported predominantly to Great Britain. New Jersey, Pennsylvania, and Georgia also exported mostly to the West Indies. These figures indicated that there was significant traffic along the

Atlantic Seaboard in both directions, with the greater portion of the traffic in Mid-Atlantic and Southern ports arriving from and traveling to England and Europe or the Caribbean, while in New England, there was more traffic coming from England and Europe, but more departing for the southern colonies or the Caribbean. Fishing and whaling vessels sailing from New England ports and Long Island would have traveled primarily on east-west and northeast-southwest routes to access Georges Bank, the Grand Banks of Newfoundland, and the North Atlantic. In general, the majority of all ship traffic was southwest-northeast along the Atlantic Seaboard following the Gulf Stream northward and the coastal currents southward. The major colonial trade routes are illustrated in Figure 12.17.

These major trade routes did not change significantly in the 19th and 20th centuries. Rather, the coastwise trade increased, while foreign trade expanded to include Central and South America, the west coast of the United States, and Asia. The Northeast continued to dominate the import business, while Southern commodities, like cotton and timber products, remained the primary export. Midwest grain also became a staple export via New Orleans. Manufactured goods from Europe and the Northeast were shipped to the South and Midwest from New England, New York, and Philadelphia.

The effect on vessel traffic of these expansions was primarily to increase the number of vessels entering and exiting U.S. ports and traveling along the Atlantic Seaboard. Ship traffic was greater over a longer period of time in the Northeast, thus the number of shipwrecks was greater in that region. This is consistent with Pearson et al.'s (2003) findings of a greater concentration of wrecks in the eastern part of the Gulf of Mexico due to the greater amount of traffic there over time. The number of vessels entering ports was greatest in the northern ports during the 17th and 18th centuries, but southern ports became increasingly important during the 19th and 20th centuries following the spread of cotton across the region. The rise of New Orleans as a shipping point for the Midwest catapulted Louisiana ahead of all states except New York in exports by 1818. Despite the rise of southern ports, Boston was the nation's busiest port until it was passed by New York in 1840, 15 years after the completion of the Erie Canal. In the late 19th century, Philadelphia became the busiest port on the Atlantic Seaboard, thanks to its booming shipbuilding industry (Huebner 1922; Johnson 1922; New York State Canal Corporation n.d.; Shepherd and Walton 1972).

The effect of vessel traffic being funneled into harbor entrances can be seen in the concentration of wrecks around the approaches to New York, Delaware and Chesapeake bays, Charleston Harbor, and the Savannah River (see Figures 12.10–12.14). The number of wrecks recorded increases as one approaches the entrance, just as the number of vessels within a given area increased as they funneled into the port or bay. Since the Chesapeake and its estuaries covered such a broad area, the traffic into that bay was considerable. Many vessels were lost as they tried to make their way between the Virginia Capes: Cape Charles on the north and Cape Henry on the south. Charleston and Savannah served as the entry point for nearly all goods coming into their colonies and were the largest ports south of Norfolk, meaning that hundreds of vessels a year approached Charleston Harbor and the Savannah River from the ocean.

All other factors being equal, the greater number of vessels that traveled through a particular area, the more wrecks are likely to occur. The increased likelihood of collision and the increased

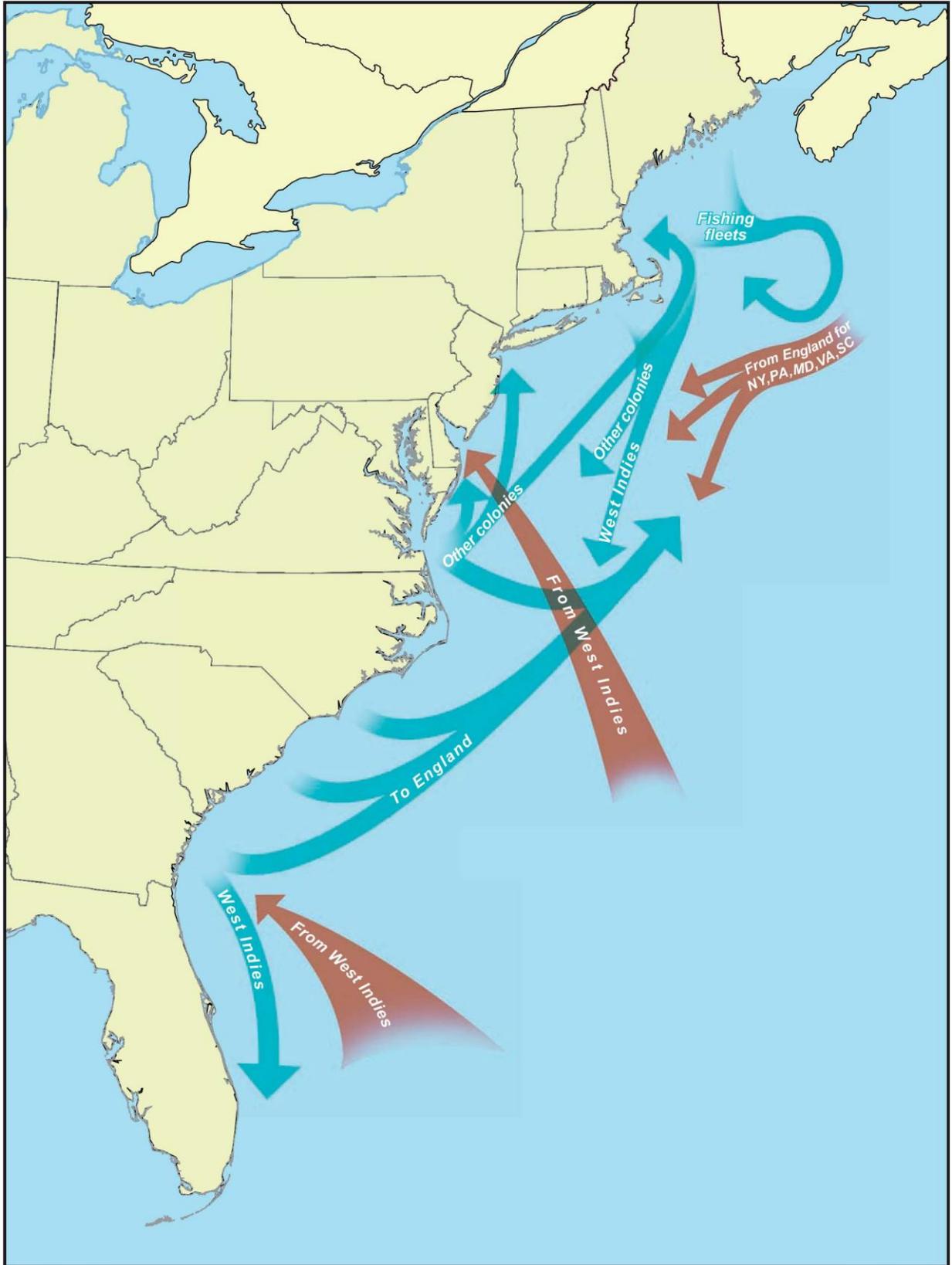


Figure 12.17. Major trade routes of colonial North America, 1769 (from Johnson 1922).

hazards in shallow water contribute to this risk. The frequency of shipwrecks around the entrances to ports and harbors is also affected by the increased presence of hazards as a ship approaches shore. Shoals are more common in shallow waters, and bars extend from capes and form at sea. Waves become steeper and less predictable closer to shore and in shallow areas farther from shore. Distressed ships often make their way toward harbors, as well, with many not making it safely before sinking or stranding. The many wrecks around Nantucket and Cape Cod, where rocky shoals and ledges are common, attest to the twin factors of heavy traffic and dangerous hazards in contributing to shipwrecks. Although shipwrecks in shallow water are more likely to be salvaged, the large number of recorded wrecks around the entrances to bays and harbors shows the effect of increased traffic within a defined area. The coastwise trade created traffic along the entire Atlantic seaboard, but the number of vessels was greatest between the busiest ports, resulting in the highest density between Boston and Philadelphia. As shipping volume migrated southward in the 19th century, the Mid-Atlantic coast became the most frequently traveled route. As a result, the coast of New Jersey, Delaware, Maryland, and Virginia appear to have the greatest concentration of shipwrecks in the OCS project area.

In addition to vessels arriving from other ports, there was a significant volume of traffic in New England ports from fishing vessels leaving from and returning to their home ports. The New England cod fleet alone numbered over 600 vessels carrying 4,400 crew members during the decade from 1765 to 1775. The vast majority sailed from Massachusetts ports for Georges Bank, about 150 miles due east of Cape Cod, or for the Newfoundland Banks farther to the northeast. Marblehead, Gloucester, Salem, and Plymouth, were the leading fishing communities. Whaling ships added further to the traffic out of Massachusetts, with smaller fleets in the various ports of New York, Connecticut and Rhode Island (Johnson 1922:154–161). The large number of wrecks shown between 100 and 200 miles off of Cape Cod in Figure 12.14 illustrate the large number of vessels plying those waters during the historical period. Commercial fishing was not as significant in the southern colonies, although the Chesapeake Bay area developed a modest trade in shad and herring during the 18th century, along with crabs and oysters. These hauls came mostly from the bay, however, so ocean-going fishing vessels were less common than in New England (Casey n.d.).

Two noteworthy areas have experienced a large number of shipwrecks due principally to navigation hazards: Cape Hatteras and the Straits of Florida (between the Florida Keys and Cuba). Although these areas do not have busy port approaches, both saw considerable traffic because of their location along major shipping routes. Cape Hatteras projects far into the Atlantic and the turbulence created by the currents around the cape, as well as the shifting sand bars that form off its point, have put thousands of ships in peril, despite the construction of lighthouses and life-saving stations in the late 19th century (Figure 12.18). Vessels traveling along the coast must pass the cape. This includes not only those going between ports on the northern and southern seaboard, but also many coming from the Caribbean, the Gulf of Mexico, or Central and South America, which utilize the strong Gulf Stream current to return to Europe from the Americas. Storms originating in the Caribbean frequently rake the Outer Banks, driving vessels north and west into the shore. Captains concerned with making the shortest passage sometimes tried to cut the distance between ports by sailing closer to the cape than advised, often resulting

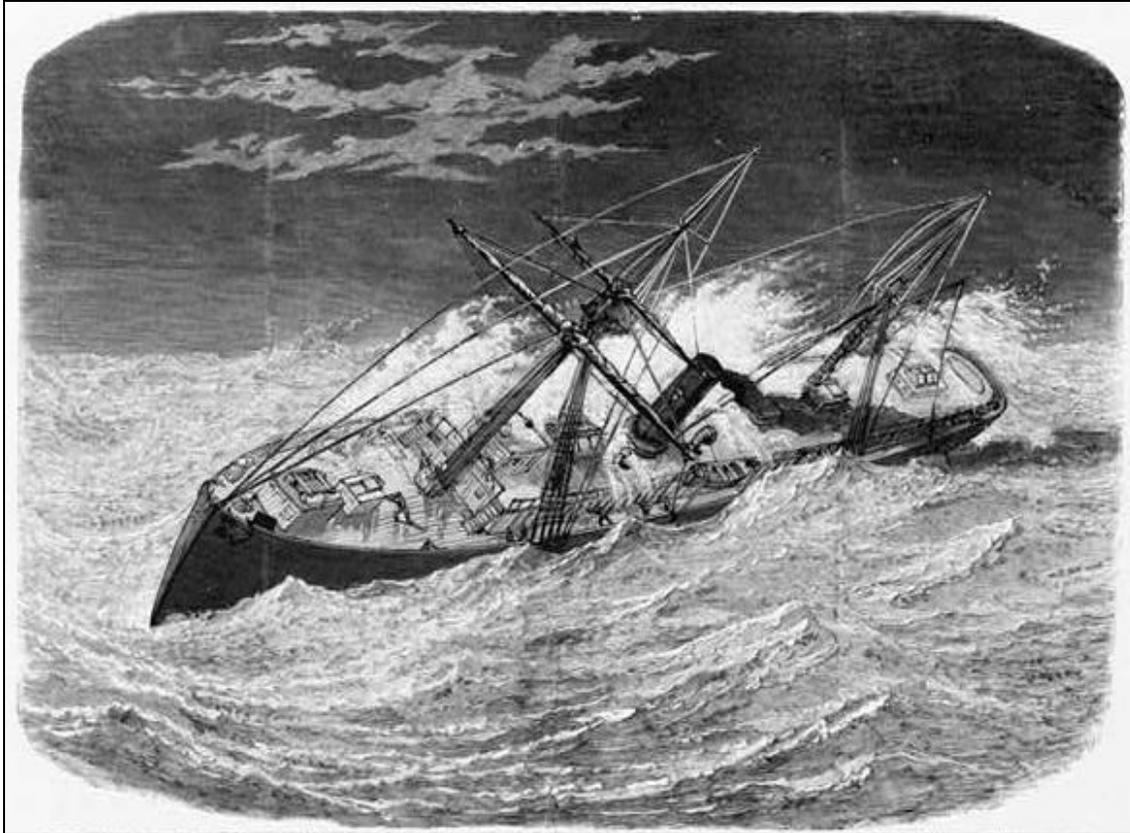


Figure 12.18. The steamer *Metropolis* was lost off Currituck Beach in 1878, 3 years after the lighthouse was put in operation there (Library of Congress).

in disaster. The large number of wrecks around Cape Hatteras has earned it the nickname, —The Graveyard of the Atlantic.”

The 90-mile wide passage between the Florida Keys and Cuba has also proven hazardous. Spanish fleets passed through the straits regularly with cargos of treasure from its colonies during the period of colonial domination of Central and South America. The numerous reefs and shoals coupled with the frequency of hurricanes during the late summer and early fall when the flotillas typically sailed led to numerous disasters over a 200-year period in the 16th and 17th centuries. The route continued to be used from the 18th century on by vessels carrying goods from New Orleans and the Gulf Coast to the east coast of the United States and Europe.

12.7. RECOMMENDATIONS FOR CULTURAL RESOURCES MANAGEMENT OF SHIPWRECKS IN THE ATLANTIC OCS

12.7.1. Implications of ASD for Survey Approaches

The purpose of compiling the Atlantic Shipwreck Database was to gather existing data, update previous inventories, and identify potential sources of new information that can be used to inform cultural resources management decisions regarding offshore leases in the Atlantic OCS. In addition to providing information on specific shipwrecks that might be located in a defined project area, the ASD can be useful for planning purposes, providing a guide for site

selection and budget considerations based on the likelihood of encountering known or unknown shipwrecks in a given area.

The zones of low, medium and high shipwreck potential defined in the previous section and shown in Figure 12.16 can be incorporated into cultural resources management planning, providing a guide for site selection, budget considerations, and even survey strategy. Lease applicants should factor whether potential cultural resource impacts can be avoided or reduced by selecting a project site in an area of lower potential. If site selection is constrained by other factors necessitating use of a high potential area, knowledge of high shipwreck potential could allow for cost planning associated with cultural resource mitigation. Since significant unknown shipwrecks could be found anywhere within the Atlantic OCS, cultural resources survey cannot be ruled out in low probability zones; however, the survey approach could be tailored to the likelihood of findings. For example, lease areas in high probability zones should be surveyed well in advance to identify all areas of concern and to develop avoidance or mitigation strategies, while low probability areas could incorporate cultural resource surveys into geophysical testing, so that in the event of encountering cultural materials, a strategy could be developed for mitigation if necessary.

BOEM survey requirements under the 2008 Notice to Lessees (NTL) and Operators for the Atlantic OCS (NTL 2008-G20) call for magnetometer survey transects of 30 meters or less. The multibeam bathymetry and backscatter intensity data, side scan sonar, and magnetometer surveys conducted as part of the applicant's project planning should be analyzed for evidence of possible shipwrecks, regardless of site potential. If the lease block in question occurs in an area where potential for submerged prehistoric sites is prompting additional survey coverage, such investigations should also serve to identify shipwrecks.

12.7.2 Suggestions for Supplemental Historic Research and Database Management

When potential or identified shipwrecks are encountered in a lease block, additional historical research will need to be carried out. Research in primary and secondary sources of information on shipwrecks revealed the high degree of inaccuracy in the data, and underscores the importance of using as many sources as possible in conducting cultural resources investigations. Shipwreck locations from actual surveys, such as AWOIS and cultural resource management reports, are useful for identifying wrecks and other anomalies on the ocean floor, but provide little information on the name or history of these features. Both primary and secondary sources generally focus on the features of the vessel and other historical information, but usually have limited locational data. Dive books and websites often include both historical and locational information, but cover a limited number of wrecks, with an emphasis on those closer to shore, in shallow waters, and with good exposure. Depending on the nature of archaeological investigations and findings, contextual information on vessel type, construction, materials, cargo, and other attributes could assist the researcher in identifying the wreck using available historical information. The location of the wreck and the type of ship uncovered will determine which sources will be most valuable in piecing together the story of the ill-fated vessel as well as its historical context. Historians, underwater archaeologists, and other consultants conducting investigations for BOEM permitted projects will be in the best position to ascertain the sources of potential relevance to their project.

Beyond the specific archival research conducted in the context of particular projects, BOEM may contemplate sponsoring additional historical research to augment the contents of the ASD. To that end, the following observations may prove valuable in allocating resources to such an effort. The relative value of the primary sources consulted in compiling the ASD is discussed in the methods section (Chapter 11), and for the most part, these sources have been sufficiently mined as part of this effort and previous research. A few sources could be covered more thoroughly, including a more systematic inventory of shipwrecks listed on internet dive guides and shipwreck related sites such as The Wreck Site (www.wrecksite.eu) and The U-boat Project (www.uboat.net). Also, the index of U.S. Coast Guard Reports of Casualty, 1913–1939, on file at the National Archives in Washington, was only searched through 1918. Although many of the wrecks reported in the index appear in other databases, the wreck cards provide a wealth of information.

Less information is available for wrecks prior to the 1850s, before government data began to be collected. Further research for the period up until the mid 19th century will likely continue to turn up wrecks previously unreported in existing shipwreck inventories, but a systematic search of sources from this period for the purpose of identifying new wrecks would require considerable time and effort for the number of wrecks that would be added. In addition, these sources rarely provide more than the vaguest location information. Of more use would be repositories dedicated to seafaring such as the Mariner’s Museum in Newport News, Virginia, the Museum of Ships and the Sea in Mystic Seaport, Connecticut, and the Independence Seaport Museum in Philadelphia. These facilities contain libraries specializing in records related to ships and seafaring, with staffs who can guide research. On-going research in these records yields an ever-expanding knowledge base that is shared among researchers and staff. During the current research effort, a total of 5 days was spent at the Mariner’s Museum Library, but considerable resources remain. The Independence Seaport Museum library was unavailable for research because of a vacancy in the staff, and time constraints precluded a visit to the Museum of Ships and the Sea. Further research at these institutions is recommended.

The ASD represents a powerful tool for cultural resources management, pulling information from a wide variety of sources on shipwrecks together in a compatible GIS database. The format preserves source data, allowing researchers access to as much information as possible from which to draw conclusions. This will aid both in locating vessels that have not yet been found and identifying those that are discovered. Ideally, as the database is put to use, entries that appear to be duplicates can be cross-referenced, while still maintaining the original source data. This is preferable to merging sources and risking perpetuating an erroneous conclusion. The database is infinitely expandable as new data is collected, and further analysis of the data will likely yield valuable information on vessel types, wreck locations, site preservation, and more.

13. CONCLUSION

The goal of this study was two-fold. First, through the contributions of various scholars doing research on underwater sites, it has revised a model for identifying areas of the Atlantic OCS where there is potential for preserved prehistoric sites. In doing so, it has addressed the following questions:

1. When were people living along the Eastern Seaboard?
2. What portions of the now-submerged Atlantic OCS were subaerial when people likely occupied the region?
3. What types of landforms were likely locations for settlement, such that sites would have been formed and left behind?
4. What is the likelihood that such sites would have survived marine transgression?
5. What methods should researchers employ to identify areas that may contain sites, and to look for sites once such areas have been identified?

The second component of this study was to conduct research and assemble a database of known and likely historic shipwrecks along the Atlantic OCS, and provide a written historic context for these wrecks. The database, which is provided under separate cover, contains over 11,000 entries and incorporates extant databases, literature on shipwrecks, state and federal data on shipwrecks, and archival research at a number of institutions along the east coast.

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APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
101	U.S. Coast Guard		Life-Saving Station Logbooks, Norfolk District (Big Kennakeet, 1879-1883).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	Daily logs that include records of weather conditions, training activities, personnel matters, etc., along with incidents. None of reported wrecks appeared to be offshore.	0
102	U.S. Coast Guard		Life-Saving Station Logbooks, Norfolk District (Big Kennakeet, 1883-1887).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	Daily logs that include records of weather conditions, training activities, personnel matters, etc., along with incidents. None of reported wrecks appeared to be offshore.	0
103	U.S. Coast Guard		Wreck Reports of Stations, Norfolk District (Little Kennakeet, 1885-1900).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	None of wrecks reported appeared to be outside 3-mile limit or there was insufficient information to determine if vessel was lost or if incident was off-shore.	0
104	U.S. Coast Guard		Wreck Reports of Stations, Norfolk District (Big Kennakeet, 1883-1899).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.		3

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
105	U.S. Coast Guard		Wreck Reports of Stations, Norfolk District (Cape Hatteras, 1883-1884).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.		1
106	U.S. Coast Guard		Wreck Reports of Stations, Norfolk District (Big Kennakeet, 1915-1918).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	None of wrecks reported appeared to be outside 3-mile limit or there was insufficient information to determine if vessel was lost or if incident was off-shore.	0
107	U.S. Coast Guard		Wreck Reports of Stations, 8th District (Ft. Lauderdale, 1911-1918).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	None of wrecks reported appeared to be outside 3-mile limit or there was insufficient information to determine if vessel was lost or if incident was off-shore.	1
108	U.S. Coast Guard		Wreck Reports of Stations, 7th District (Durants Station, 1910-1917).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	No wrecks reported outside 3 mile limit	0

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
109	U.S. Coast Guard		Wreck Reports of Stations, 7th District (Gilberts Bar, 1886-1918).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	No wrecks reported outside 3 mile limit	0
110	U.S. Coast Guard		Wreck Reports of Stations, Norfolk District (Little Kennakeet, 1901-1921).	Record Group 26, National Archives and Records Administration, Southeast Region Branch, Morrow, Georgia.	No wrecks reported outside 3 mile limit	0
111	Association of Underwater Explorers	2009	Shipwrecks.	Online document, http://uwex.us/wreckinfo.html		38

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
112	U.S. Coast Guard		Reports of Casualty, 1913-1939, Index (Microfilm, 7 rolls).	Record Group 26, Records of the U.S. Coast Guard, National Archives and Records Administration, Washington, D.C.,	Index cards are stamped "rivers," "lakes," "Atlantic" (including Gulf of Mexico) and cause ("collision," stranding," and other causes). Total losses are also stamped. Includes info on date of loss, location, nature of accident, cause, cargo, insurance on vessel, insurance on cargo, passengers, crew, lives lost, tonnage, and age. Arranged fiscal year and then alphabetically by ship's name. Record info from cards marked "Atlantic" and "Total Loss," omitting those located in inland or nearshore waters. [4/22 -started 1917-18 completed A-C]	130
113		1837	New York Shipping and Commercial List, 1837.	On file, Library of Congress, Washington, D.C.	Disasters are published on p. 3 of each issue. Published twice weekly on Wed. and Sat.	0

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
114	U.S. Bureau of Marine Inspection and Navigation	1880	Merchant Vessels of the United States with the Official Numbers and Signal Letters Awarded Them by the Chief of the Bureau of Statistics.	Government Printing Office, Washington, D.C.	Does not include losses. Covers FY ending June 30, 1880. Arranged by merchant vessels and U.S. government vessels. Merchant vessel info includes sailing ships, steam ships, unriggered vessels, arranged alphabetically and by number. Government vessels divided into Navy, Revenue Marine, Lighthouse Board, and Coast Survey. Approximately 20,800 merchant vessels listed. Details included official number, class, name, tonnage, and home port.	0
115	U.S. Bureau of Marine Inspection and Navigation	1886	Merchant Vessels of the United States with the Official Numbers and Signal Letters Awarded Them by the Commissioner of Navigation.	Government Printing Office, Washington, D.C.	Does not include losses, but has pictures of all types of sailing ships.	0
116	U.S. Bureau of Marine Inspection and Navigation	1914	Merchant Vessels of the United States with the Official Numbers and Signal Letters and List of Vessels Belonging to the United States Government with Distinguishing Signals. 46th Annual Edition.	Government Printing Office, Washington, D.C.	Has same info as 1880 list, but with the addition of "Loss of American Vessels." Same as source 137	0

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
118	same as 117					0
119	U.S. Bureau of Marine Inspection and Navigation	1882-1884	Annual Reports of the Supervising Inspector-General of Steamboats to the Secretary of the Treasury for the Fiscal Year Ending June 30.	Government Printing Office, Washington, D.C.	Contains summaries of fatal accidents. A review of Dist. 213, which includes the U.S. Coast from GA-ME (& Atlantic FL?), does not give enough detail to know if accidents involved sinking in Federal waters.	0
120	U.S. Steamboat Inspection Service	1869	Proceedings of the Seventeenth Annual Meeting of the Board of Supervising Inspectors of Steam Vessels, Held at Washington, D.C., January 1869.	Government Printing Office, Washington, D.C.	Has individual district reports, including data on lost ships.	2
121	U.S. Steamboat Inspection Service	1888	Proceedings of the 36th Annual Meeting of the Board of Supervising Inspectors of Steam Vessels, Held at Washington, D.C., January, 1888; Also, reports of Supervising Inspectors of the Year ended December 31, 1887, and Revised Rules and Regulations.	Government Printing Office, Washington, D.C.		3
122	U.S. Steamboat Inspection Service	1899	Annual Report of the Supervising Inspector-General, Steamboat Inspection Service, for the Fiscal Year Ended June 30, 1899.	Government Printing Office, Washington, D.C.	Includes reports of Supervising Inspectors for 1898	7
123	U.S. Steamboat Inspection Service	1903	Annual Report of the Supervising Inspector-General, Steamboat Inspection Service, for the Fiscal Year Ended June 30, 1903.	Government Printing Office, Washington, D.C.	Includes reports of Supervising Inspectors for the year ending Dec. 31, 1902	3
124	U.S. Steamboat Inspection Service	1915-1918	Steamboat Inspection Service Bulletin. Nos. 1-30, Nov. 1, 1915-Mar. 1, 1918.	Government Printing Office, Washington, D.C.	Includes "Accidents to Vessels under the Jurisdiction of the Steamboat Inspection Service" for some issues. Issued monthly.	17

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
125	U.S. Steamboat Inspection Service	1918- 1932	Steamboat Inspection Service Bulletin. Nos. 31-202, May 1, 1918-Aug. 1, 1932.	Government Printing Office, Washington, D.C.	Includes "Accidents to Vessels under the Jurisdiction of the Steamboat Inspection Service."	34
126	U.S. Steamboat Inspection Service	1900	Annual Report of the Supervising Inspector- General, Steamboat Inspection Service for the Fiscal Year Ended June 30, 1900.	Government Printing Office, Washington, D.C.	Contains reports of Supervising Inspectors for 1899	1
127	U.S. Steamboat Inspection Service	1901	Annual Report of the Supervising Inspector- General, Steamboat Inspection Service for the Fiscal Year Ended June 30, 1900.	Government Printing Office, Washington, D.C.	Contains reports of Supervising Inspectors for 1900	1
128	U.S. Steamboat Inspection Service	1904	Annual Report of the Supervising Inspector- General, Steamboat Inspection Service for the Fiscal Year Ended June 30, 1904.	Government Printing Office, Washington, D.C.	Contains reports of Supervising Inspectors for part of 1902 and for 1903	1
129		1815- 1818	<i>New York Shipping and Commercial List.</i>	On file, Library of Congress, Washington, D.C.	Published twice weekly on Tues and Fri. Does not list out disasters or losses separately. Recorded by hand to resource forms.	63
130		1824- 1829	<i>New York Shipping and Commercial List.</i>	On file, Library of Congress, Washington, D.C.	Published twice weekly on Wed and Sat. Lists wrecks and incidents but only a few each issue, and some issues not at all.	85

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
131	U.S. Steamboat Inspection Service	1903-1915	Records of American Vessels Lost, compiled, 1903-1915.	Record Group 41, Bureau of Marine Inspection and Navigation, U.S. Steamboat Inspection Service.	1 volume of pasted pages from annual reports. Appendix J of report compiling vessels reported as total losses for FY ended June 20, 1903-June 30, 1915. Report includes type of vessel, name, gross tonnage, year built, nature of accident, place, and date. Arranged by year and then alphabetically by ship name. Photographed.	41
132	U.S. Steamboat Inspection Service	1852-1899	Proceedings of the Board of Supervising Inspectors of Steam Vessels, 1852-1899.	Record Group 41, Bureau of Marine Inspection and Navigation, U.S. Steamboat Inspection Service.	15 vols., various formats. Steamboat inspection law passed 1852. Steamboat Inspection Service (Dept. of Treasury) merged with Bureau of Navigation in 1932. See source form for notes on individual reports.	25
133	U.S. Coast Guard	1790-1937	Histories of Revenue Cutters, compiled, 1790-1937.	Record Group 26, Records of the U.S. Coast Guard, National Archives and Records Administration, Washington, D.C.,	12 vols. Includes name of ship; when, where and by whom built; date ordered; dates of actions; date sold, salvaged, lost, etc.; record of officers. Starting with vol. 5 (1904) adds hull material and contract price.	0

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
134	U.S. Steamboat Inspection Service	1871-1903	Index to Reports of Casualties and Violations of Law, 1871-1903.	Record Group 41, Bureau of Marine Inspection and Navigation, U.S. Steamboat Inspection Service.	2 vols. Only lists name of vessel, district, page, and proceeding of annual report. Not of use.	0
135		1820-1823	New York Shipping and Commercial List.	On file, Library of Congress, Washington, D.C.		41
136		1830-1832	New York Shipping and Commercial List.	On file, Library of Congress, Washington, D.C.	Photographed	0
137	U.S. Steamboat Inspection Service	1914	Loss of American Vessels Reported during Fiscal Year 1914, and List of Vessels of the United States Measured under Panama Canal Rules. In Forty-Sixth Annual List of Merchant Vessels of the United States with Official Numbers and Signal Letters, and List of Vessels Belonging to the U.S. Government with Distinguishing Signals for the Year Ended June 30, 1914.	Government Printing Office, Washington, D.C.	Photocopied at Library of Congress	15
138	U.S. Steamboat Inspection Service	1907	Loss of American Vessels Reported during Fiscal Year 1906, and List of Vessels of the United States Measured under Panama Canal Rules. In Forty-Sixth Annual List of Merchant Vessels of the United States with Official Numbers and Signal Letters, and List of Vessels Belonging to the U.S. Government with Distinguishing Signals for the Year Ended June 30, 1907.	Government Printing Office, Washington, D.C.		1

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
139	U.S. Steamboat Inspection Service	1909	Annual Report of the Supervising Inspector-General, U.S. Steamboat Inspection Service to the Secretary of Commerce and Labor for the FY Ended June 30, 1910.	Government Printing Office, Washington, D.C.	Includes annual reports of casualties by supervising and local districts for year ended December 31, 1909.	11
140	Canney, Donald L.	1995	U.S. Coast Guard and Revenue Cutters, 1790-1935.	Naval Press Institute Press, Annapolis, Maryland		13
141	U.S. Coast Guard		Disaster Files.	Historian's Office, USCG Headquarters, Washington, D.C.	Vertical files organized by ship name include transcripts of communication during SAR operations, newspaper clippings, photographs, incident reports, and results of investigations. Information for individual ships varies widely. Most files date from the 1940s to present, with a few going back to the 20s and 30s.	40
142	U.S. Bureau of Navigation	1917-1960	Merchant Vessels of the United States.	Government Printing Office, Washington, D.C.	Contains losses of U.S. Vessels	1
143	Shanks, Ralph C.	1996	U.S. Life-Saving Service: Heroes, Rescues and Architecture of the Early Coast Guard.	Constano Books, Petaluma, California.		0

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
144	Snow, Edward Rowe	1944	Great Storms and Famous Shipwrecks of the New England Coast	The Yankee Publishing Company, Boston.	Narrative; does not provide much locational information. Author examined slightly under 9,500 wrecks and over 650 storms for their importance.	3
145	<i>New York Times</i>	1926	Solvang's Crew Landed; 24 Men Saved; Praise Work of the Vacuum Sailors in Storm	NYT online, 1/27/26. http://nytimes.com .		0
146	<i>New York Times</i>	1889	Cleopatra Steamship.	NYT online, 10/31/1889. www.nytimes.com/ref/membercenter/nytarchive.html .		1
147	U.S. Steamboat Inspection Service	1908	Annual Report of the Supervising Inspector- General, Steamboat Inspection Service to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1908.	Government Printing Office, Washington, D.C.		7
148	U.S. Steamboat Inspection Service	1909	Annual Report of the Supervising Inspector- General, Steamboat Inspection Service to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1909.	Government Printing Office, Washington, D.C.		3
149	Mystic Seaport: The Museum of America and the Sea		Mystic Seaport online subject index: objects. Http://mobius.mysticseaport.org .	Mystic, Connecticut.		1
150	U.S. Steamboat Inspection Service		Ms 2931, report.	On file, Rare Books and Manuscripts, Boston Public Library, Boston.		3

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
151	Weldon, Thomas	1683	Report of the loss of the <i>Swallow</i> in March 1683, recorded in the Book of Records, Public Notary, Boston.	Transcription of the record, Boston Public Library, Ms. AM 1502, vo. 5, no. 24. Boston Public Library, Boston.		1
152	Mather, Increase	1684	An Essay for the Recording of Illustrious Providences, Wherein an Account Is Given of Many Remarkable and Very Memorable Events, Which Have Happened This Last Age, Especially in New England.	On file, Boston Public Library, Boston.		1
153	Durrie and Peck	1834	The Mariner's Chronicle: Containing Narratives of the Most Remarkable Disasters at Sea, Such as Shipwrecks, Storms, Fires, and Famines; Also, Naval Engagements, Piratical Adventures, Incidents of Discovery, and Other Extraordinary and Interesting Occurrences.	Durrie and Peck, New Haven, Connecticut. On file, Boston Public Library, Boston.		1
154	A Friend of Mariners (compiler)	1823	Accounts of Shipwrecks and Other Disasters at Sea: Designed to be Interesting and Useful to Mariners, with an Appendix Containing Dr. Payson's Address to Seamen; and a Few Prayers for Their Use.	Joseph Griffin, Brunswick, Maine.		3

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
155	U.S. Coast Guard	1883-1920	Wreck Reports of Life-Saving Stations, 1883-1920	Record Group 26, Records of the U.S. Coast Guard, National Archives and Records Administration, Northeast Region Branch, Waltham, Massachusetts.	Organized alphabetically by name of station. Recorded all shipwrecks that appeared to be offshore, total loss, and containing significantly different info from other databases. Examined compiled reports from 14 stations in ME, NH, MA, and RI covering various periods.	10
156	U.S. Customs Service	1874-1954	Wreck Reports of Customs Stations, Northeast District, 1874-1954	Record Group 36, Records of the U.S. Customs Service, National Archives and Records Administration, Northeast Region Branch, Waltham, Massachusetts.	See entries for specific customhouse report.	108
157	Ellms, Charles (compiler)	1836	Shipwrecks and Disasters at Sea, or Historical Narratives of the Most Noted Calamities, and Providential Deliveries from Fire and Famine on the Ocean.	Russell, Shattuck, and Company, Boston.	Many pages were missing. None of the accounts cover a shipwreck in the Atlantic OCS.	0

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
158		1840	Awful Calamities: or, The Shipwrecks of December, 1839; Being a full account of the dreadful hurricanes of December 15, 21 & 27 on the coast of Massachusetts; in which were lost more than 90 vessels and nearly 200 dismasted, driven ashore or otherwise damaged and more than 150 lives destroyed, of which full statistics are given; comprising also a particular relation of the shipwreck of the following vessels: Barque <i>Lloyd</i> , Brigs <i>Pocahontas</i> , <i>Rideout</i> and <i>J. Palmeri</i> , and Schooners <i>Deposite</i> , <i>Catherine Nichols</i> and <i>Miller</i> , and also of the deadly disasters at Gloucester.	3rd edition. J. Howe, Boston.		5
159	Committee of the Boston Board of trade	1855	Report to Boston Board of Trade and a Memorial to Congress on the Subject of Seamen and Marine Disasters.	Boston Journal Office, Boston.		0

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
160	Procter, George H.	1873	The Fisherman's Memorial and Record Book, Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873.	Procter Brothers, Gloucester, Massachusetts.	Capitulation of lost ships and seamen by year. Photographed (SDC 11656-SDC 11699). 1437 names and 296 vessels, including those lost in the gale of August 24, 1873. Unfortunately does not give detailed location info. Most were lost in the Georges Bank Fishing Grounds, Canadian Waters, or the North Atlantic. Georges Bank is within the OCS. Other locations given are just "lost mackerel fishing." Cod and halibut taken from Georges Bank. Halibut apparently more plentiful at Grand Bank, mackerel at Bay of St. Lawrence.	90
161	Procter Brothers	1882	The Fishermen's Own Book: Comprising the list of men and vessels lost from the port of Gloucester, Mass., from 1874 to April 1, 1882, and a table of losses from 1830, together with valuable statistics of the fisheries, also notable fares, narrow escapes, startling adventures, fishermen's off-hand sketches, ballads, descriptions of fishing trips and other interesting facts and incidents connected with this branch of maritime industry.	Procter Brothers, Gloucester, Massachusetts.	See photos of pp. 66-75 (SDC 11700-11725).	3

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162	Humane Society of the Commonwealth of Massachusetts	1899-1909	Rescue and case reports, 1899-1909.	Massachusetts Historical Society manuscript collection, Ms. N-872. MHS, Boston.	See forms for more detailed location information	1
163	Preble, George H.		Scrapbook of clippings related to shipwrecks and maritime disasters. George H. Preble Papers.	Massachusetts Historical Society manuscript collection, Ms. N-739. MHS, Boston.		3
164	Gardner, Arthur H. (compiler)	1954	Wrecks around Nantucket Since the Settlement of the Island, and the Incident Connected Therewith, Embracing over Seven Hundred Vessels, with Additional records to 1954. Reprinted. Originally published in 1877 as A List of Wrecks around Nantucket.	On file, Massachusetts Historical Society, Boston.	Appears to have been reprinted in 1943 and again in 1954 with additional material. Have not looked at yet. Looking for copy to purchase.	0
165	Kimball, John R. H.	2005	Disaster, etc.: The Maritime World of Marblehead, 1815-1865.	Peter E. Randall Publisher, LLC, Portsmouth, New Hampshire.	Have not looked at this yet. Looking for copy to purchase.	0
166	Ratray, Jeanette Edwards	1973	Perils of the Port of New York: Maritime Disasters from Sandy Hook to Execution Rocks.	Dodd, Mead & Company, New York.		96
168	Marx, Robert F.	1981	Shipwrecks of the Western Hemisphere, 1492-1825.	The World Publishing Company, New York.		0
170	Gray, Edwyn	2003	Disasters of the Deep: A Comprehensive Survey of Submarine Accidents and Disasters.	Naval Institute Press, Annapolis, Maryland.	No new wrecks to add.	4
172	Berman, Bruce D.	1972	Encyclopedia of American Shipwrecks, Section 1	The Mariners Press, Inc., Boston, Massachusetts		163

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
173	Berman, Bruce D.	1972	Encyclopedia of American Shipwrecks, Section 2	The Mariners Press, Inc., Boston, Massachusetts		116
174	BFDC	2007	North Carolina Wreck Diving.	Online, http://www.nc-wreckdiving.com . Accessed, September 2009.		14
175	Aqua Explorers, Inc.	n.d.	Aqua Explorers, Inc. and Capt. Dan Berg's Wreck Valley Shipwreck Charter Boat.	Online, http://www.aquaexplorers.com . Accessed September 2009.		0
176	Berg, Daniel and Denise Berg	1991	Florida Shipwrecks: The Diver's Guide to Shipwrecks around the State of Florida and the Florida Keys..	Aqua Explorers, Inc., East Rockaway, New York.		74
177	Chappelle, Howard I.	1949	The History of the American Sailing Navy: The Ships and Their Development.	Bonanza Books, New York.		0
178	Preble, George Henry	1883	A Chronological History of the Origin and Development of Steam Navigation, 1543- 1882.	L. R. Hamersly & Company, Philadelphia.		1
179	British Parliamentary Papers	1836	Extract from Report of the Select Committee on Shipwrecks, XVII (XXX) for Vessels to Ports Outside of U.K., Appendix 7, Return of all Vessels belonging to the United Kingdom, reported on the Books of Lloyd's as WRECKED, and of all Vessels reported as MISSING or not heard of, in the Years 1816, 1817, and 1818.	The Ships List - Shipwrecks 1816-1818. Online document, http://www.theShipsList.com/ships/wrecks/wrecks1816-1818.html .		9
180	Gentile, Gary	1992	Shipwrecks of Virginia	Gary Gentile Productions, Philadelphia.		292
181	Pouliot, Richard A and Julie J. Pouliot	1986	Shipwrecks on the Virginia Coast and the Men of the United States Life-Saving Service.	Tidewater Publishers, Centerville, Maryland.		16

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182	Galiano, Rich	2009	Scuba Diving - New Jersey and Long Island, New York	Online document, http://njscuba.net/sites/index/html		74
183	Tidewater Atlantic Research, Inc.	1999	A Submerged Cultural Resources Survey of Four Proposed Borrow Areas and Archaeological Diver Identification and Evaluation of Eight Potentially Significant Submerged Targets for the Brevard County Shore Protection Project, Brevard County, Florida.	Tidewater Atlantic Research, Inc., Washington, North Carolina. Submitted to Jacksonville District Office, U.S. Army Corps of Engineers, Jacksonville, Florida.		33
184	U.S. Navy	2006	Photo #80-G-177164, Official U.S. Navy photo, now in National Archives. Online document, http://www.history.navy.mil/photos/images/g100000/g177164c.htm/ . Accessed Nov. 6, 2009.	U.S. Naval Historical Center, Naval History and Heritage Command.		1
185	Conkwright, Robert D., and Rebecca A. Gast	1994	Potential Offshore Sand Resources in Central Maryland Shoal Fields. Appendix C. Coastal and Estuarine Geology File Report No. 94-9	Maryland Geological Survey, Baltimore. Submitted to Minerals Management Service, U.S. Department of the Interior.		4
186	Morris, Jeffrey D.	1997	Phase I Archaeological Study, Ocean City Water Resources Study, Ocean City, Maryland.	Garrow & Associates, Inc., Raleigh, North Carolina. Submitted to Baltimore District Office, U.S. Army Corps of Engineers, Baltimore.		5

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
187	Watts, Gordon P., Jr.	2007	Archaeological Remote Sensing Survey of Offshore Borrow Areas near Sandbridge Beach, Virginia.	Tidewater Atlantic Research, Inc., Washington, North Carolina. Submitted to Wilmington District Office, U.S. Army Corps of Engineers, Wilmington, North Carolina.		11
188	Quinn, William P.	1979	Shipwrecks around New England: A Chronology of Marine Accidents and Disasters from Grand Manan to Sandy Hook.	Lower Cape Publishing Company, Orleans, Massachusetts.		1
189	Robinson, David S. and Martha R. Williams	1996	Phase I Remote Sensing Marine Archeological Survey of the Proposed Dredge Site at Sandbridge Shoal, Virginia Beach, Virginia.	R. Christopher Goodwin & Associates, Inc., Frederick, Maryland. Submitted to Naval Facilities Engineering Command, Atlantic Division, Norfolk, Virginia.		2
190	Science Applications, Inc.	1981	A Cultural Resources Survey of the Continental Shelf from Cape Hatteras to Key West: Final Report, Vol. III, Appendices.	Science Applications, Inc., McLean, Virginia. Submitted to Bureau of Land Management, New Orleans, Louisiana.		129
191	New York Times	1910	Fears Schooner is Lost	New York Times Online, 20 November, 1910.		1

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
192	Hall, Wes	2007	An Archaeological Remote Sensing Survey of Bouge Banks Offshore Borrow Areas, Carteret County, North Carolina	Mid-Atlantic Technology and Environmental Research, Inc. Submitted to U.S. Army Corps of Engineers, Wilmington, NC.		0
193	Wilde-Ramsing, Mark (compiler)	2009	Eighteenth Century Shipwrecks in the Beaufort Inlet Area. Queen Anne's Revenge website, www.quaronline.org/history/shipwrecks.htm . Accessed 20 Nov., 2009.	Queen Anne's Revenge Project, Underwater Archaeology Branch, North Carolina Department of Cultural Resources, Morehead City, North Carolina.		4
194	R. Christopher Goodwin & Associates, Inc.	2004	Historic Assessment and Remote Sensing Survey of the Duval County Shore Protection Sand Source, Duval County, Florida.	R. Christopher Goodwin & Associates, Inc., Frederick, Maryland. Submitted to U.S. Army Corps of Engineers, Jacksonville District, Jacksonville, Florida.		3
195	MMS	n.d.	Side Scan Sonar and Multibeam Echosounder Images.	MMS		5
196	MMS	n.d.	Side Scan Sonar Images from MMS			7
197	Ecology and Environment, Inc. and INTEC Engineering	2006	Deepwater Port License Application, Calypso LNG Project, Florida, Volume III Technical Attachments.	Calypso LNG, LLC, Houston, Texas. Submitted to U.S. Coast Guard, Deepwater Ports Standards Division, Washington, D.C.		0

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
198	Williamson and Associates, Inc. and Geoscience Earth & Marine Services, Inc.	2001	Geohazards Assessment, Proposed 24-Inch Gas Pipeline Route, Freeport, Grand Bahama Island to Port Everglades, Florida.	Williamson and Associates, Inc., Seattle, Washington, and Geoscience Earth & Marine Services, Inc., Houston, Texas. Submitted to Calypso Pipeline LLC and Hawksbill Creek LNG Ltd, Houston, Texas.		0
199	Lydecker, Andrew D. W., Michael C. Krivor, Stephen R. James, Jr., and Michael Faught	2006	Marine Cultural Resources Analysis of Remote Sensing Survey Data Associated with Calypso LNG Project Offshore Florida.	Panamerican Consultants, Inc., Memphis, Tennessee. Submitted to Suez Energy North America, Inc.		0
200	Fugro Geoservices, Inc.	2002	Archeological and Hazards Survey Report for Offshore Navy Restricted Area Variation to the Proposed 24-Inch Ocean Express Pipeline from Revised Mile Post 40.5, United States Federal Waters, to Revised Mile Post 48, Broward County, Florida: Ocean Express Pipeline Project, Report No. 2402-1185.	Fugro Geoservices, Inc., Lafayette, Louisiana. Submitted to AES Ocean Express LLC, Coral Gables, Florida.		3
201	Gentile, Gary	2002	Shipwrecks of Delaware and Maryland.	Gary Gentile Productions, Philadelphia.		250
202	Gentile, Gary	2003	Shipwrecks of South Carolina and Georgia	Gary Gentile Productions, Philadelphia.		161
203	Barnette, Michael C.	2003	Shipwrecks of the Sunshine State.	Association of Underwater Explorers, n.p.		306

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
204	Ocean Surveys, Inc.	2006	Shallow Hazards Survey report, MS Lease Blocks 6574, 6575, & 6625, Detailed Geophysical and Geotechnical Investigations, Northeast Gateway Pipeline Lateral, Massachusetts Bay and Offshore Waters.	Ocean Surveys, Inc., Old Saybrook, Connecticut. Submitted to Algonquin Gas Transmission, LLC, Waltham, Massachusetts.		0
205	PAL	2005	Marine Archaeological Reconnaissance Survey, Northeast Gateway Pipeline Lateral: Appendix 4F.	PAL, Pawtucket, Rhode Island. Submitted to Algonquin Gas Transmission, Waltham, Massachusetts.		3
206	U.S. Army Corps of Engineers	n.d.	Archaeological Remote Sensing Survey of Myrtle Beach Offshore Borrow Areas, Horry County, South Carolina.	U.S. Army Corps of Engineers, Wilmington District, Wilmington, NC.		1
207	Charles, Joan	1997	Mid-Atlantic Shipwreck Accounts to 1899: Over 1400 Entries for New Jersey, Pennsylvania, Delaware, Delaware Bay, Maryland, Virginia, Chesapeake Bay, North Carolina.	Published by the author, Hampton, Virginia.		7
208	Charles, Joan	1999	Mid-Atlantic Shipwreck Accounts to 1914: Over 1700 Entries for New Jersey, Pennsylvania, Delaware, Delaware Bay, Maryland, Virginia, Chesapeake Bay, North Carolina.	Published by the author, Hampton, Virginia.		0
209	Duncan, P.	1810	Authentic and Interesting Accounts of the Most Popular Shipwrecks That Have Occurred from Ancient Dates to the Present Time.	Published by the author, Plymouth, [Mass?]		1
210	Spence, E. Lee	1984	Shipwrecks of South Carolina and Georgia (includes Spence's List, 1520-1865).	Sea Research Society, Sullivan's Island, South Carolina.		61

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211	Huntress, Keith	1979	A Checklist of Narratives of Shipwrecks and Disasters at Sea to 1860, with Summaries, Notes, and Comments.	Iowa State University Press, Ames.		2
212	Thomas, R.	1835	Interesting and Authentic Narratives of the Most Remarkable Shipwrecks, Fires, Famines, Calamities, Providential Deliveries, and Lamentable Disasters on the Seas in Most Parts of the World.	Silas Andrus & Son, Hartford, [Conn?].		0
213	Gentile, Gary	1990	Shipwrecks of Delaware and Maryland.	Gary Gentile Publications, Philadelphia.		0
214	Singer, Steven D.	1992	Shipwrecks of Florida: A Comprehensive Listing.	Pineapple Press, Sarasota, Florida.		4
215	Quinn, William P.	2004	Shipwrecks along the Atlantic Coast: A Remarkable Collection of Photographs of Maritime Accidents from Maine to Florida.	Commonwealth Editions, Beverly, Massachusetts.		0
216	Quinn, William P.	1988	Shipwrecks along the Atlantic Coast: A Collection of Photographs of Maritime Accidents from Maine to Florida.	Parnassus Imprints, Orleans, Massachusetts.		2
217	Emmerson, John C.	1956	Shipwrecks along the North Carolina and Virginia Coasts, 1799-1939.	Published by the author, Portsmouth, Virginia.		0
218	Charles, Joan	2003	New Jersey, Delaware, Pennsylvania, Shipwreck Accounts, 1705 to 1950, Including Delaware Bay and Delaware River.	Published by the author, Hampton, Virginia.		61
219	Charles, Joan	2004	North Carolina Shipwreck Accounts, 1709 to 1950, Including over 1100 Named Wrecks.	Published by the author, Hampton, Virginia.		68
220	Charles, Joan	2004	Virginia and Maryland Shipwreck Accounts, 1623 to 1950, Including Chesapeake Bay: Over 1200 Named Wrecks.	Published by the author, Hampton, Virginia.		62

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
221	Maginnis, Arthur J.	1892	The Atlantic Ferry: Its Ships, Men, and Working.	Whitaker and Company, London.		4
222	Londale, Adrian L. and H. R. Kaplan	1964	A Guide to Sunken Ships in American Waters.	Compass Publications, Inc., Arlington, Virginia.		5
223	Charles, Joan	1997	Mid-Atlantic Shipwreck Accounts to 1899: Over 1400 Entries for New Jersey, Pennsylvania, Delaware, Delaware Bay, Maryland, Virginia, Chesapeake Bay, North Carolina.	Published by the author, Hampton, Virginia.		20
224	Charles, Joan	1999	Mid-Atlantic Shipwreck Accounts II to 1914: Over 1700 Entries for New Jersey, Pennsylvania, Delaware, Delaware Bay, Maryland, Virginia, Chesapeake Bay, North Carolina.	Published by the author, Hampton, Virginia.		30
225	Lloyd's List	1762	Lloyd's List.	Lloyd's, London.		4
226	New York State Historic Preservation Office	2010	New York State Shipwreck Report.	Historic Preservation Field Services Bureau, Office of Parks, Recreation and Historic Preservation, Waterford, New York.		33
227	U.S. Customs Service	1874-1925	Wreck Reports of Customs Stations, Southeast District, 1874-1925	Record Group 36, Records of the U.S. Customs Service, National Archives and Records Administration, Southeast Region Branch, Atlanta, Georgia.	See entries for specific customhouse report.	66

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
228	North Carolina Department of Cultural Resources	2010	World War II Shipwrecks off the North Carolina Coast (electronic database).	North Carolina Department of Cultural Resources, Office of the Deputy State Archaeologist, Raleigh.		73
229	North Carolina Department of Cultural Resources	2010	Off-shore Shipwrecks of North Carolina Coast (selected from electronic database by location code).	North Carolina Department of Cultural Resources, Office of the Deputy State Archaeologist, Raleigh.		51
230	Carroll, Patrick	n.d.	Wilmington Diving.	Online publication, www.wilmingtondiving.com/wrecks.shtml . Published by the author, Wilmington, NC.		4
231	Shomette, Donald G.	2007	Shipwrecks, Sea Raiders, and Maritime Disasters along the Delmarva Coast.	Johns Hopkins University Press, Baltimore.		306
232	Luther, B. W. and Edwin Weeks	1967	New England Shipwrecks.	Prepared for Boston Sea Rovers, Thirteenth Annual International Underwater Clinic. On file, Board of Underwater Archaeological Resources, Boston.		0
233	Morris, Paul C. and William P. Quinn	1989	Shipwrecks in New York Waters.	Parnassus Imprints, Orleans, Massachusetts.		0
234	Feliciano, Frank	n.d.	The 1733 Galleon Fleet.	SunkenTreasure.com, www.sunkentreasure.com/1733 . Accessed June 14, 2010.		4

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
235	Aqua Explorers, Inc.	2006	Loran and GPS Shipwreck Location Coordinates: New Jersey, New York, Connecticut, Rhode Island, & Massachusetts.	Aqua Explorers, Inc., Baldwin, New York.		162
236	Aqua Explorers, Inc.	2009	Delaware-Maryland Loran and GPS Shipwreck Location Coordinates.	Aqua Explorers, Inc., Baldwin, New York.		18
237	Aqua Explorers, Inc.	2009	South Carolina-Georgia Loran and GPS Shipwreck Location Coordinates.	Aqua Explorers, Inc., Baldwin, New York.		34
238	Aqua Explorers, Inc.	2006	New Jersey and New York Artificial Reef Loran and GPS Coordinates.	Aqua Explorers, Inc., Baldwin, New York.		0
239	Berg, Daniel	1990	Wreck Valley, Vol. II: A Record of Shipwrecks off Long Island's South Shore and New Jersey.	Aqua Explorers, Inc., Baldwin, New York.		0
240	Minerals Management Service	n.d.	Shipwreck Research File.	On file, Minerals Management Service, Environmental Assessment Section, New Orleans, Louisiana.		36
241	Florida Division of Historical Resources	2010	Florida Shipwreck Site File.	On file, Florida Division of Historical Resources, Tallahassee.		6
242	Virginia Department of Historic Resources	2010	Virginia Shipwreck Database.	On file, Virginia Department of Historic Resources, Richmond.		2
243	Freitag, Norbert	1998	Shipwrecks Unforgotten: From New Jersey to the Gulf of Florida.	Finley-Greene Publications, Island Park, New York.		3168

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
244	Spirek, James D. and Christopher F. Amer (editors)	2004	A Management Plan for Known and Potential United States Navy Shipwrecks in South Carolina.	Maritime Research Division, South Carolina Institute of Archaeology and Anthropology, Columbia. Prepared for the Naval historical Center, Washington, D.C.		9
245	Maine Historic Preservation Commission	2010	Maine Wrecks in Federal Waters.	On file, Maine Historic Preservation Commission, Augusta, Maine.		32
246	U.S. Navy		Partial List of Foundered U.S. Navy Craft, U.S. Navy database (March 2009): Known U.S. Navy Sunken Military Watercraft along the Atlantic Seaboard	Dept. of the Navy, Naval History & Heritage Command, Underwater Archaeology Branch, 805 Kidder Breese Street SE, Washington Navy Yard, DC 20374-5060		638
247	U.S. Customs Service	1874-1954	Wreck Reports of Customs Stations, Northeast District, 1874-1954	Record Group 36, Records of the U.S. Customs Service, National Archives and Records Administration, Northeast Region Branch, New York, New York.	See entries for specific customhouse report.	30

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
248	U.S. Customs Service	1802-1904	Wreck Reports of Customs Stations, Northeast District, Collection District of Little Egg Harbor, New Jersey. Record of Wrecks.	Record Group 36, Records of the U.S. Customs Service, National Archives and Records Administration, Northeast Region Branch, New York, New York.		6
249	U.S. Coast Guard	1883-1920	Wreck Reports of Stations, New York and New Jersey.	RG 26, Records of the U.S. Coast Guard, National Archives and Records Administration, Northeast Region Branch, New York, New York.	See entries for specific life saving station.	10
250	U.S. Coast Guard	1887-1924	Wreck Reports of Customs Districts, Maryland and Delaware.	RG 26, Records of the U.S. Coast Guard, National Archives and Records Administration, Mid-Atlantic Region Branch, Philadelphia, Pennsylvania.	See entries for specific customhouse report.	342

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Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
251		1856	Shipping and Mercantile Gazette	On file, Library of Congress, Washington, D.C.	Section titled "Maritime Extracts" includes wrecks; organized by port reporting allowing U.S. ports to be extracted. Losses in federal waters of the Atlantic may be reported in other ports, but reviewing all entries would be time consuming and yield few results. Photographing 7 months of daily entries required 4 hours. Pulling relevant wrecks from those entries required 3 hours and yielded 9 wrecks. This paper later merged with Lloyd's List and the effort required would be similar for Lloyd's, although earlier editions of Lloyd's, starting in 1741, are bi-weekly and would not have as many entries as the late nineteenth century editions when shipping volume was at its peak.	13
252	Lochhead, John L.	1954	Disasters to American Vessels, Sail and Steam, 1841-1846, Compiled from the New York Shipping and Commercial List.	Mariners Museum, Newport News, Virginia.	No new wrecks to add. These are abstracted in Joan Charles' books for the Mid-Atlantic States.	0

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
253	Minerals Management Service	2009	Atlantic Shipwreck Database.			2016
254	Gaines, W. Craig	2008	Encyclopedia of Civil War Shipwrecks.	Louisiana State University Press, Baton Rouge.		5
255	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 1.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		64
256	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 2.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		287
257	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 3.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		70
258	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 4.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		75
259	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 5.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		696

APPENDIX A – SOURCES USED FOR SHIPWRECK DATABASE

Source #	Author	Year	Title/Description	Publisher/Location	Notes	No. of Entries (includes combined entries)
260	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 6.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		64
261	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 7.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		342
262	Office of Coast Survey		Automated Wreck and Obstruction Information System. Region 8.	National Oceanographic and Atmospheric Administration, Silver Spring, Maryland		125
263	U.S. Navy		Non-Submarine Contact List - Wreck Features	U.S. Navy, Office of Global Navigation/Technology National, Geospatial-Intelligence Agency	Data provided to us as a GIS shape file.	858
264	Helgason, Gudmundur	2011	The U-Boat Wars, 1939-1945 (Kriegsmarine) and 1914-1918 (Kaiserliche Marine) and Allied Warships	http://uboat.net/index.html	Includes information on U-boats sunk, as well as warships and merchant vessel hit by U-boats	53

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
101	N/A	N/A	Daily logbooks are handwritten in narrative form and contain considerable information not related to shipwrecks. After reviewing these at NARA Southeast Region, it was determined that these records were not a productive source of information on shipwrecks in the Atlantic OCS.	Minimal. May provide additional information on the circumstances of a particular wreck if the date and location are known.	100	NC
102	N/A	N/A	Daily logbooks are handwritten in narrative form and contain considerable information not related to shipwrecks. After reviewing these at NARA Southeast Region, it was determined that these records were not a productive source of information on shipwrecks in the Atlantic OCS.	Minimal. May provide additional information on the circumstances of a particular wreck if the date and location are known.	100	NC

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
103	N/A	N/A	Wreck reports were recorded on forms after approximately 1873, and 37 categories of data were requested. Not all categories were included with every report, but they are generally complete. Data reported includes: Station reporting, date of incident, vessel name, home port, origin, destination, nationality, rig, tonnage, number of crew, number of passengers, number of persons lost, vessel owner, vessel master, age of vessel, cargo, value of vessel, value of cargo, cause of wreck, time of incident, tides, weather conditions, location of wreck, amount of loss, names of casualties, value of cargo lost, and a report of the incident by the master or other party. Location of wreck is usually given as a distance and heading from a landmark. When coordinates are given, these are likely provided by the captain of the vessel after the fact.	Minimal. All extant wreck reports for the Eastern Seaboard were reviewed and all of the information transferred to the database using the categories included. In some cases there may be notational information or data that was not part of the resource forms that was not included, and it is possible that some reports were overlooked, but this source has been thoroughly reviewed.	100	NC
104	N/A	N/A	See Source 103	See Source 103	100	NC
105	N/A	N/A	See Source 103	See Source 103	100	NC
106	N/A	N/A	See Source 103	See Source 103	100	NC
107	N/A	N/A	See Source 103	See Source 103	100	FL
108	N/A	N/A	See Source 103	See Source 103	100	VA
109	N/A	N/A	See Source 103	See Source 103	100	FL
110	N/A	N/A	See Source 103	See Source 103	100	NC

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
111	LORAN	Unknown	Website contains narrative descriptions and map locations of wrecks off the coast of Delaware, Maryland, Virginia, North Carolina, and Florida. The level of detail varies depending on the wreck. The information is based on document research and diver reports and includes data on condition of wreck, exposure, depth, etc.	Much of the narrative information for these wrecks was not included in the database, so this is a good source for further information on the circumstances of particular wrecks and their reported condition. The website is updated periodically, it is a good source for information on new vessels and updates on old sites.	100	DE, MD, VA, NC, FL
112	N/A	N/A	Information contained on the index card is extensive, but more information is likely contained on the actual reports, which were not examined due to time constraints. These are similar to the Coast Guard Wreck Reports noted in source 103.	Significant. Cards were examined for a limited date range, and many more vessels might be identified for the period after World War I. Wrecks from this period are well reported in compiled records of other agencies; however, the extensive data on cargo, tonnage, amount of loss, etc., may not be included in other records. Also, location information is more precise in these reports than in compiled reports.	20	Eastern Seaboard
113	See source 129	See source 129	See source 129	See source 129	0	Eastern Seaboard

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
114	N/A	N/A	See notes	Minimal. Losses are not listed. This list can provide vessel data on specific vessels known to have been lost, but this same information is available in other sources.	100	Eastern Seaboard
115	N/A	N/A	See notes for source 114	See source 114	100	Eastern Seaboard
116	Lat/Long (degrees-minutes)	Unknown	Official number, rig, vessel name, gross tonnage, year built, number on board, number lost, nature of casualty, date of casualty, and location of casualty.	Moderate. All data from the source was recorded from all vessels that were included in the database. However, location information was generally vague (except when lat/longs were used), making it impossible to determine if a wreck was in the Atlantic OCS. It is possible that some of those not recorded may, in fact, be within the OCS. If further location information is found on a particular wreck, this source can provide the data indicated in the "Type of Information" column.	100	Eastern Seaboard
117	N/A		Vessel name, captain, home port, date of loss if known, cause of loss if known, general location of loss if known	Moderate. Published weekly, includes disasters, but very fragile and difficult to go through.	25	Eastern Seaboard
118	same as 117					

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
119	N/A	N/A	Vessel name, cause of loss, date of loss, location of loss, origin, and destination	Minimal. Location details are generally vague and vessel data is limited. Most volumes of this series were reviewed for this project (see sources 121-128).	100	Eastern Seaboard
120	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
121	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
122	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
123	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
124	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
125	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
126	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
127	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
128	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
129	Lat/Long (degrees-minutes)	Unknown	Vessel name, captain, home port, date of loss if known, cause of loss if known, general location of loss if known	Moderate. Issues after 1830 were not reviewed and have potential to turn up previously unreported losses. Reviewing the issues takes considerable time with a limited return however, and location information is very general. Reports sometimes contain errors, as well. Library of Congress holdings after 1832 do not appear to be complete, but run to 1898.	100	Eastern Seaboard
130	Lat/Long (degrees-minutes)	Unknown	See source 129	See source 129	100	Eastern Seaboard
131	Lat/Long (degrees-minutes)	Unknown	See source 116	See source 116	100	Eastern Seaboard
132	Lat/Long (degrees-minutes)	Unknown	See source 119	See source 119	100	Eastern Seaboard
133	N/A	N/A	Vessel name, vessel type, cause of loss, year built, place built, builder.	None. Review complete.	100	Eastern Seaboard
134	N/A	N/A	Name of vessel, district, page and proceeding or annual report.	None. Not of use.	100	Eastern Seaboard
135	Lat/Long (degrees-minutes)	Unknown	See source 129	See source 129	100	Eastern Seaboard
136	Lat/Long (degrees-minutes)	Unknown	See source 129	See source 129	0	Eastern Seaboard

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
137	Lat/Long (degrees-minutes)	Unknown	Official number, rig, vessel name, gross tonnage, year built, number on board, number lost, nature of casualty, date of casualty, and location of casualty.	Moderate. All data from the source was recorded from all vessels that were included in the database. However, location information was generally vague (except when lat/longs were used), making it impossible to determine if a wreck was in the Atlantic OCS. It is possible that some of those not recorded may, in fact, be within the OCS. If further location information is found on a particular wreck, this source can provide the data indicated in the "Type of Information" column.	100	Eastern Seaboard
138	Lat/Long (degrees-minutes)	Unknown	See source 137	See source 137	100	Eastern Seaboard
139			See source 119	See source 119	100	Eastern Seaboard
140	N/A	N/A	Vessel name, vessel type, date of loss, year built, where built, builder, length, beam, depth, armament, location info for some entries.	None, Review complete.	100	Eastern Seaboard
141	Lat/Long (degrees-minutes-seconds)	Unknown, probably 1927.	See notes.	Minimal. These are updated periodically, but generally the review of files is complete.	100	Eastern Seaboard

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
142	Lat/Long (degrees-minutes)	Unknown	See source 137	High. These records were not reviewed past 1923 due to time constraints. Location information is vague, so additional research is necessary, but these annual volumes provide a good starting point for information on yearly losses of vessels.	20	Eastern Seaboard
143	N/A	N/A	No specific info on shipwrecks	None	100	Eastern Seaboard
144	N/A	N/A	Narrative descriptions that do not provide much locational information. Author reports that over 9,200 wrecks and 650 storms were researched.	Minimal. More information is available on most wrecks in other sources.	100	NE
145	N/A	NA	General location and number of crew saved	More information on vessel may be available by paying for the entire article.		
146	N/A	N/A	See entry	None	100	DE
147	Lat/Long (degrees-minutes)	Unknown	See source 120	See source 120	100	Eastern Seaboard
148	Lat/Long (degrees-minutes)	Unknown	See source 120	See source 120	100	Eastern Seaboard
149	N/A	N/A	See entry	Moderate to high. Mystic Seaport Museum has an extensive collection, including a significant amount of information online. Only a cursory review was conducted.	0	Eastern Seaboard

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
150	Lat/Long (degrees-minutes-seconds)	Unknown	Vessel name, date of loss, cause of loss, number of crew and passengers, number lost, vessel type, origin, destination, value of vessel and cargo for one entry	None. All of manuscript was reviewed.	100	Eastern Seaboard
151	N/A	N/A	Only basic info in narrative form.	Minimal	100	NE
152	N/A	N/A	Only basic info in narrative form.	Minimal	100	NE
153	N/A	N/A	Only basic info in narrative form.	Minimal	100	NE
154	N/A	N/A	Only basic info in narrative form.	Minimal	100	NE
155	N/A	N/A	See Source 103	See Source 103	100	Eastern Seaboard
156	Lat/Long (degrees-minutes)	Unknown	Form completed by customs officials generally included the official number, name of vessel, date of loss, cause of loss, number of crew and passengers, number lost, location of loss, master, vessel type, age of vessel, tonnage, home port, origin, destination, cargo, owner, value of vessel and value of cargo. Other information was sometimes included such as hull material, vessel length, number of masts, and a brief description of the incident.	Minimal. All extant customs wreck reports for the Eastern Seaboard were reviewed and all of the information transferred to the database using the categories included. In some cases there may be notational information or data that was not part of the resource forms	100	NE, NY, NJ
157	N/A	N/A	Narrative descriptions of selected wrecks.	None. Wrecks discussed were not within the Atlantic OCS.	100	Eastern Seaboard
158	N/A	N/A	Narrative descriptions of selected wrecks. Limited physical data on vessels. Typically included were vessel name, approximate date of loss, location of loss, and port of origin. Other information was provided for some vessels. See entries.	Minimal. Information was reviewed for vessels likely located in Atlantic OCS.	100	NE, Mid Atlantic
159	N/A	N/A	None.	None.	100	NE

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
160	N/A	N/A	Varied. Typically included were vessel name, date of loss, cause of loss, number of crew and passengers, number lost, location of loss, master, vessel type, owner, and value of the vessel.	Minimal. Book was reviewed and all likely wrecks in the Atlantic OCS were recorded. The names of crew members were likely to be listed, but these names were not recorded as part of the data collection. This is a good source of that information.	100	NE
161	N/A	N/A	See source 160	See source 160	100	NE
162	N/A	N/A	Basic information on vessel, location, date, master, and cause of loss when known.	None. Manuscripts were reviewed for wrecks in the Atlantic OCS, and only one found.	100	NE
163	N/A	N/A	Basic information on vessel, location, master, location and cause of loss when known.	Minimal. Some of the wrecks described may be in the Atlantic OCS, but because of vague or unknown location information were not recorded.	100	NE, Mid Atlantic
164	Unknown	Unknown	Unknown	High. This volume was not reviewed because of time constraints.	0	NE
165	Unknown	Unknown	Narratives of maritime disasters. Not necessarily concerned with shipwrecks.	Moderate. This volume was not reviewed because of time constraints. It is more concerned with stories than providing shipwreck location information, however.	0	MA

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
166	N/A	N/A	Basic information on vessel name and type, date and cause of loss, location, cargo, origin and destination, and other available information.	Minimal. List was reviewed for losses that were likely more than 3 miles from shore. Most listings are not, or location information is too vague to determine.	100	NY, NJ
168	N/A	N/A	Basic information on vessel name and type, date and cause of loss, location, cargo, origin and destination, and other available information. Location information is very vague.	Minimal. This volume has been a basic source of shipwreck information for many years. Most of the wrecks listed here were found on other inventories that had more specific location information.	100	Eastern Seaboard
170	N/A	N/A	Vessel name, date of loss, nationality, cause of loss, number of crew lost, and number of survivors.	Limited. Location information is very generalized. List was reviewed for wrecks likely to be in Atlantic OCS.	100	Eastern Seaboard
172	Lat/Long (degrees-minutes-seconds)	Unknown	Vessel name, rig, tonnage, year built, date of loss, cause of loss, location, and comments.	Moderate. Only wrecks with coordinate information and located in the project area were recorded because of time constraints.	10	Eastern Seaboard
173	Lat/Long (degrees-minutes-seconds)	Unknown	Vessel name, rig, tonnage, year built, date of loss, cause of loss, location, and comments.	Moderate. Only wrecks with coordinate information and located in the project area were recorded because of time constraints.	10	Eastern Seaboard

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
174	Lat/Long (degree-decimal minutes), LORAN	Unknown	Extensive information on vessel type, size, propulsion, builder, owner, year built, cargo, cause of loss, location, etc. Includes photos of many vessels, both before loss and from diver visits. Not all of the information could be recorded to database.	High. Great source of information on vessels as well as wreck condition. Considerable information that could not be recorded to forms. Location information varies from vague to very specific, and is in different formats. This is an active webpage and is updated periodically. Some wreck pages are still under construction.	100	NC, VA
175	N/A	N/A	Tabular and narrative information on the vessels and wrecks, including how the vessel wrecked, what happened to the crew, what was on board, and the depth and condition of the wreck in recent years.	High. Thorough research has been conducted on many of these wrecks. The location information for these wrecks is recorded under sources 176, 235, 236, and 237. Descriptive information for Florida wrecks are included under source 176. The websites referenced in the notes section of the ASD or aquaexplorers.com should be consulted for descriptive information for wrecks listed in sources 235-237.	100	NY, NJ

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
176	LORAN	Unknown	History and wreck site information on approximately 194 wrecks on the east coast of Florida and the Keys. Of these, 109 appeared to be more than 3 miles from shore.	Moderate. Descriptive information from the vessel histories was recorded to the ASD for all vessels that appeared to be in the Atlantic OCS. Considerable detail is included in the book that could not be recorded on the forms, and this is a good source for information and photos of vessels.	100	FL
177	N/A	N/A	Detailed descriptive information on Naval vessels. It is not specifically concerned with wrecks and was used primarily as a reference.	High. Contains plan drawings and detailed descriptions of vessels used by the U.S. Navy. An important reference.	100	Eastern Seaboard
178	N/A	N/A	Detailed descriptive information on steam vessels. It is not specifically concerned with wrecks and was used primarily as a reference.	Moderate. Contains valuable information on steamships in general. Not concerned with wrecks.	100	Eastern Seaboard
179	N/A	N/A	Vessel name, year of loss, cause when known, general location, nationality, origin and destination,.	Limited. Only covers 3 years and all entries were reviewed.	100	Eastern Seaboard

APPENDIX B – RESEARCH POTENTIAL FOR SOURCES CONSULTED

Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
180	Lat/Long (degrees-decimal minutes); LORAN	NAD83	Extensive list of wreck names and locations, with detailed text on selected wrecks. Locations in ASD are based on Lat/Longs when available, otherwise on LORAN.	High. Detailed descriptions were not included, but can be found in the original source for selected wrecks. These descriptions include information on the vessel, cause of the loss, and the condition of the wreck, as well as many other details.	100	VA
181	N/A	N/A	Vessel name, date of loss, vessel type, nearest life-saving station, location, lives lost, lives saved, value of vessel and cargo.	Moderate. Location information is vague for many wrecks so some vessels not recorded may be in Atlantic OCS.	100	VA
182	N/A	N/A	Narrative description includes information on vessel, crew, location and cause of loss, and condition of the wreck.	Moderate. Some information could not be entered in database, and website is actively updated.	100	NY, NJ
183	N/A; UTM	Unknown	Historic vessels lost in vicinity are reported along with vessel type, tonnage when known, date of loss, and general location. Results of survey note magnetic contour signature and water depth.	Minimal. All relevant information recorded.	100	FL
184	Lat/Long (degrees-minutes)	Unknown	General information on sinking of vessel by German submarine.	None	100	FL
185	Lat/Long (degrees-decimal minutes)	NAD83	Side scan sonar anomalies	None	100	MD

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
186	N/A	N/A	Table of known historic shipwrecks in project vicinity that includes name of vessel, date of loss, general location, vessel type, vessel size, and source of information.	None	100	MD
187	VA SPCS	NAD83	Magnetic and acoustic anomalies from survey	None	100	VA
188	N/A	N/A	Unknown	Low. The shipwreck in the database from this reference appears to have come from another source. This source was examined, but apparently was not useful.	0	NE
189	N/A	N/A	Table of known historic shipwrecks in project vicinity that includes name of vessel, date of loss, general location, vessel type, tonnage, cargo and lives lost.	None	100	VA
190	Lat/Long (varied formats)	Unknown (presumed to be NAD27)	Table containing name, vessel type, nationality, date built, tonnage, nearest state, lat-long, location description, date lost, and cause.	Minimal. All relevant data has been added.	100	NC, SC, GA, FL
191	N/A	N/A	General information on lost vessel.	None	100	NC
192	NC SPCS	NAD83	Historic vessels lost in vicinity are reported along with vessel type, tonnage when known, date and cause of loss, and general location. Results of survey note magnetic contour signature and sonar ID.	None	100	NC
193	N/A	N/A	Name and type of vessel, date of loss, and general location.	Minimal. All relevant data has been added.	100	SC

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
194	N/A	N/A	Historic shipwrecks in vicinity are noted with name, type, date, location, and source.	None.	100	FL
195	Lat-Long (degrees-minutes-decimal seconds)	NAD27	Side scan sonar image and multibeam echosounder image,	Moderate. Image can provide details on the anomaly.	100	NJ
196	Lat/Long (decimal degrees)	NAD83	Side scan sonar image.	Moderate. Image can provide details on the anomaly.	100	NJ
197	UTMs	NAD83	Side scan sonar image.	None. Not in project area.	100	FL
198				None. Not in project area.	100	FL
199				None. Not in project area.	100	FL
200	UTM	NAD83	Location, dimensions, sonar image.	Minimal. Sonar images.	100	FL
201	Lat/Long (degrees-decimal minutes); LORAN	NAD83	Extensive list of wreck names and locations, with detailed text on selected wrecks. Locations in ASD are based on Lat/Longs when available, otherwise on LORAN.	High. Detailed descriptions were not included, but can be found in the original source for selected wrecks. These descriptions include information on the vessel, cause of the loss, and the condition of the wreck, as well as many other details.	100	DE, MD

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
202	Lat/Long (degrees-decimal minutes); LORAN	NAD83	Extensive list of wreck names and locations, with detailed text on selected wrecks. Locations in ASD are based on Lat/Longs when available, otherwise on LORAN.	High. Detailed descriptions were not included, but can be found in the original source for selected wrecks. These descriptions include information on the vessel, cause of the loss, and the condition of the wreck, as well as many other details.	100	SC, GA
203	Lat/Long (degrees-decimal minutes); LORAN	NAD83	Extensive list of wreck names and locations, with detailed text on selected wrecks. Locations in ASD are based on Lat/Longs when available, otherwise on LORAN.	High. Detailed descriptions were not included, but can be found in the original source for selected wrecks. These descriptions include information on the vessel, cause of the loss, and the condition of the wreck, as well as many other details.	100	FL
204				None. Not in project area.	100	MA
205	UTM	Unknown	Location, magnetic intensity and signature, line, depth.	Moderate. Image can provide details on the anomaly.	100	MA
206	SC SCPS	NAD83	Magnetic and acoustic anomalies from survey.	Minimal. Sonar image.	100	SC
207	Lat/Long (degrees-minutes-seconds)	Unknown	Abstracted from newspaper and trade paper accounts, as well as government reports. Information varies depending on source.	Minimal. Entries were reviewed for wrecks that appeared to be in Atlantic OCS and that were not already recorded from the original source.	100	NJ, PA, DE, MD, VA, NC

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
208	N/A	N/A	Abstracted from newspaper and trade paper accounts, as well as government reports. Information varies depending on source.	Minimal. Entries were reviewed for wrecks that appeared to be in Atlantic OCS and that were not already recorded from the original source. None were noted.	100	NJ, PA, DE, MD, VA, NC
209	N/A	N/A	Vessel name and rig, approximate date and cause of loss, general location, origin and destination.	Minimal. Reviewed for wrecks that appear to be in project area and only one noted.	100	Eastern Seaboard
210	Lat/Long (degrees-minutes)	Unknown	Taken from a number of sources including newspapers. Information varies based on source. Very few with coordinate data.	Minimal, All entries were reviewed.	100	SC, GA
211	N/A	N/A	Basic information on vessel, rig, nationality, date, and location.	Minimal. All entries were reviewed.	100	Eastern Seaboard
212	N/A	N/A	General narrative descriptions of wrecks, with vague location information	Minimal. No wrecks were recorded.	100	Eastern Seaboard
213				Minimal. 2002 edition was used.	0	DE, MD
214	N/A	N/A	Vessel name and rig, approximate date and cause of loss, general location, cargo, origin and destination.	Moderate. Location information is vague for most wrecks and other Florida shipwreck volumes more detailed, so not fully reviewed.	10	FL
215	N/A	N/A	Narrative descriptions of wrecks with photos.	Minimal. Most wrecks near shore and locational info difficult to extract.	100	Eastern Seaboard
216	Lat Long (degrees-minutes)	Unknown	Minimal information (name, date, rig, location)	None. All entries were reviewed.	100	Eastern Seaboard

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
217	N/A	N/A	Narrative typescripts and newspaper clippings with vague location info. Many vessels were not lost.	Moderate. Reviewed 25 pages without recording any wrecks.	10	NC, VA
218	Lat/Long (degrees-minutes-seconds)	Unknown	Abstracted from newspaper and trade paper accounts, as well as government reports. Information varies depending on source.	Minimal. Entries were reviewed for wrecks that appeared to be in Atlantic OCS and that were not already recorded from the original source.	100	NJ, PA, DE
219	Lat/Long (degrees-minutes-seconds)	Unknown	Abstracted from newspaper and trade paper accounts, as well as government reports. Information varies depending on source.	Minimal. Entries were reviewed for wrecks that appeared to be in Atlantic OCS and that were not already recorded from the original source.	100	NC
220	Lat/Long (degrees-minutes-seconds)	Unknown	Abstracted from newspaper and trade paper accounts, as well as government reports. Information varies depending on source.	Minimal. Entries were reviewed for wrecks that appeared to be in Atlantic OCS and that were not already recorded from the original source.	100	VA, MD
221	N/A	N/A	Vessel name, date of loss, owner, nationality, general location.	Minimal. This volume was used primarily as a reference.	100	Eastern Seaboard
222	Lat/Long (degrees-decimal minutes)	NAD27	Name, date, location, depth, some notes on cargo or cause of loss.	Minimal. All entries were reviewed.	100	Eastern Seaboard
223	Lat/Long (degrees-minutes-seconds)	Unknown	Abstracted from newspaper and trade paper accounts, as well as government reports. Information varies depending on source.	Minimal. Entries were reviewed for wrecks that appeared to be in Atlantic OCS and that were not already recorded from the original source.	100	Mid Atlantic

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
224	Lat/Long (degrees-minutes-seconds)	Unknown	Abstracted from newspaper and trade paper accounts, as well as government reports. Information varies depending on source.	Minimal. Entries were reviewed for wrecks that appeared to be in Atlantic OCS and that were not already recorded from the original source.	100	Mid Atlantic
225	N/A	N/A	General information on vessel, captain, origin and destination, location of loss.	Moderate. Locational information is vague and often inaccurate. More likely to note loss of British and other international vessels than some American sources. Considerable effort required to identify losses.	1	Eastern Seaboard
226	N/A	N/A	Vessel name and type, description, location, depth, history (date when known), source of information.	Moderate. Mark Peckham of the NY SHPO culled these sites from a database of over 1,100 wrecks. May not be complete.	unk	NY
227	Lat/Long (degrees-minutes)	Unknown	See source 156	See source 156	100	VA, NC, GA, SC, FL
228	Lat/Long (degrees-minutes-seconds)	NAD83	Vessel name and type, location, cause of loss, cargo, and other notes.	Minimal. NC SHPO pulled these files from an electronic database based on shape files of the project area.	100	NC
229	Lat/Long (degrees-minutes-seconds)	NAD83	Vessel name and type, location, cause of loss, cargo, and other notes.	Minimal. NC SHPO pulled these files from an electronic database based on shape files of the project area.	100	NC

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
230	N/A	N/A	Vessel name and type, location, cause of loss, nationality, and some notes on vessel length and tonnage.	Moderate. Active website that may be updated.	100	NC
231	Lat/Long (degrees-minutes-seconds)	Unknown	Vessel name and type, date and cause of loss, and location.	Minimal. All entries were reviewed.	100	DE, MD, VA
232				Minimal. No wrecks were recorded.	100	NE
233				Minimal. No wrecks were recorded.	100	NY
234	Lat/Long (degrees-decimal minutes); LORAN	Unknown	Vessel name, alternate name, tonnage, cargo, location,	None. All entries were reviewed.	100	FL
235	Lat/Long (decimal degrees)	NAD83	Vessel name and location. Additional information on selected wrecks found at www.njscuba.net	Moderate. More information on selected vessels can be found on website, which is actively updated.	100	NE, NY, NJ
236	Lat/Long (decimal degrees)	NAD83	Vessel name and location. Additional information on selected wrecks found at www.njscuba.net	Moderate. More information on selected vessels can be found on website, which is actively updated.	100	DE, MD
237	Lat/Long (decimal degrees)	NAD83	Vessel name and location. Additional information on selected wrecks found at www.njscuba.net	Moderate. More information on selected vessels can be found on website, which is actively updated.	100	SC, GA

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
238	Lat/Long (decimal degrees)	NAD83	Vessel name and location. Additional information on selected wrecks found at www.njscuba.net	Moderate. More information on selected vessels can be found on website, which is actively updated.	100	NY, NJ
239	LORAN	Unknown	Vessel name and type, location, date of loss, hull material, length, beam, cargo, depth.	Minimal. All listings were reviewed. Some information in text for 3 wrecks that are not in the database.	100	NY, NJ
240	Lat/Long (degrees-minutes)	Unknown	Forms contain date lost, vessel name, vessel type, date constructed, dimensions, tonnage, origin and destination, circumstances of loss, salvage efforts, home port, and source of information.	None. All records were reviewed.	100	Eastern Seaboard
241	Lat/Long (degrees-minutes-seconds)	Unknown	State site number, vessel name, location, date of loss, site size, wreck depth, bottom type, vessel type, date constructed, where constructed, hull material, propulsion, vessel dimensions, tonnage, origin and destination, cause of loss, cargo, home port, owner, nationality, reported by, and notes.	Minimal. Sites were selected from an electronic database using shapefiles to locate wrecks in the project area. Other wrecks in the state site file may be in the project area with undefined location or near the 3-mile boundary. List is updated periodically, so sites may be added.	100	FL
242	N/A	N/A	Unknown	Minimal. State SHPO's office checked database and found no wrecks outside of 3-mile boundary.	100	VA

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
243	Lat/Long (degrees-minutes-seconds); LORAN	Unknown	Description generally includes vessel type, cause and date of loss, general location, and condition of wreck.	High. Descriptive information was not included due to time constraints. Many of these listings are likely recorded elsewhere, so the location information can be cross referenced with other entries.	100	Mid Atlantic, Southeast
244	Lat/Long (degrees-minutes)	Unknown	Vessel type, date and cause of loss, length, armament, and comments.	None. All files were reviewed.	100	SC
245	N/A	N/A	State site number, vessel name, date of loss, cause of loss, year built, general location description, source of information	Minimal. State SHPO's office checked database for wrecks outside of 3-mile boundary.	100	ME
246	Lat/Long	Unknown	Similar fields to ASD, but not all fields filled in for each wreck.	None. All relevant records added to ASD.	100	Eastern Seaboard
247	Lat/Long (degrees-minutes)	Unknown	See source 156	See source 156		NE, NY, NJ
248	Lat/Long (degrees-minutes)	Unknown	See source 156	See source 156		NE, NY, NJ
249	Lat/Long (degrees-minutes)	Unknown	See source 156	See source 156		NY, NJ
250	Lat/Long (degrees-minutes)	Unknown	See source 156	See source 156		MD, DE

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
251			Varies, but generally includes vessel name, captain, home port, date of loss if known, cause of loss if known, general location of loss if known. Sometimes includes cargo or other details.	See notes, App. A	1	Eastern Seaboard
252	N/A	N/A		None. See notes, App. A		Eastern Seaboard
253	Lat/Long (decimal degrees)	NAD83	Vessel name or identification, year of loss, nationality for a few wrecks.	Minimal. Only about 15 percent include coordinate information, and the remainder have no location information at all.	100	Eastern Seaboard
254	Lat/Long	Unknown	Vessel name and type, date and cause of loss, propulsion type, vessel dimensions, tonnage, location, and notes.	Minimal. All entries were reviewed.	100	Eastern Seaboard
255	Lat/Long	NAD83	Most entries include vessel name or identification, coordinate location, and depth, with additional info on vessel size, previous reports, and other information contained in the notes section.	None. All entries located in project area are included.	100	ME, NH, MA
256	Lat/Long	NAD83	See source 255	See source 255	100	MA, RI, NY
257	Lat/Long	NAD83	See source 255	See source 255	100	NY, NJ
258	Lat/Long	NAD83	See source 255	See source 255	100	NY, NJ
259	Lat/Long	NAD83	See source 255	See source 255	100	NJ, DE, MD, VA
260	Lat/Long	NAD83	See source 255	See source 255	100	VA
261	Lat/Long	NAD83	See source 255	See source 255	100	VA, NC, GA, SC
262	Lat/Long	NAD83	See source 255	See source 255	100	FL

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Source #	Original Coordinate System	Original Datum	Type of Information contained in source	Research potential for more time spent on it	Percent of records reviewed for source	Geographic region
263	Unknown; it was projected in our GIS as WGS-1984 in decimal degrees, which is nearly identical to Lat/Long NAD-83			The NSC database contains separate shape files for other features, including one for "rocks," one for "dangers," and one for "foul ground," which were not included in the shipwreck database.	100	Eastern Seaboard
264	Lat/Long (decimal degrees)	Unknown	Vessel name, commanders, date of loss, vessel type, tonnage, cargo, crew, number lost, nationality, origin and destination, year built, where built, etc.	High. Narratives concerning incidents have information that was not included on forms. Site is updated regularly. Locations of sinkings are plotted on maps with coordinate information.		Eastern Seaboard



The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.



The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.